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A French soldier removing the fuse from an unexploded German shell

THE JUNK MEN OF THE WAR [See page 264]

Biological Effects of Centrifugal Action*

A Study of the Causes of Disturbances of Equilibrium

By Hughes Clément, Dr. Sc.; Preparer in Comparative Physiology, University of Lyons

EIGHT years ago, being at the time engaged in studying disturbances of equilibrium consequent on lesions of the semi-circular canals, it occurred to me to subject young vertebrate animals, not yet adult, to centrifugal action in order to observe what effect this might have upon their future equilibrium.

Not being provided at that time with apparatus perfected for the object in view, I was soon forced to give up these experiments because of the great obstacle offered by the weight of the animals. I then conceived the idea of treating hen's eggs in this manner, and, in case they hatched subsequently, examining the behavior of the chicks. Two of these did hatch—and they were of minute size. Such was the curious fact which led me to take up the study of centrifugation in a systematic manner, and to record the disturbances it might engender in living matter.

I lack space to enter here into the description of the apparatus utilized in the course of my researches. I will merely give a resumé of my experiments with respect to the effects of centrifugal force in the following categories:

1. Upon solutions, salts, gels, and their passage through membranes.
2. Upon the cell.
3. Upon the sexual elements, eggs, seeds.
4. Upon nymphs.
5. Upon adult animals.
6. Upon plants.

A certain number of authors had been occupied with this question previous to myself. But while my predecessors were engaged in microscopic researches, my own have been, on the contrary, generally macroscopic, capable of being recorded by physico-chemical or physiologic methods.

To discover the effects of centrifugal force upon solutions, I performed the following experiments:

After having noted that solutions in repose during a lapse of years were no more dense in their deeply-lying layers than in their superficial ones, I attempted to modify this equilibrium by centrifugation.

Cryoscopy, the calculation of densities, the investigation of superficial tensions, show that it was possible to rupture the homogeneity of solutions—this rupture, however, being very fleeting.

Hydrogels and salts of metals, on the contrary, could not be modified. I succeeded merely in expelling a few drops of water from a gel of gelatine—and this was in very special conditions.

While centrifugal force does not modify in any way the microzymases, it acts very energetically, on the contrary, upon the macrozymases.[2]

These results being known, it seemed advisable to me to observe how the same solutions or salts would behave in the presence of membranes.

My first attempts had in view the production of chemical tissues (of the Læduc type) in a centrifugator in motion. Every formula requiring a gelatine medium and a vat[3] must be rejected because of the fragility of the growths considered. But it is easy to obtain "artificial plants" with a base of silicate. The products making their appearance in the apparatus are much smaller than the controls, do not attach themselves to the walls of the tubes, and present the simplest forms. From a certain number of experiments upon pseudo-cells, microbroids,[4] one may conclude also that osmosis and diffusion under the action of centrifugal force yield manifestations which differ from those which are normal.

Osmotic phenomena are considerably increased by centrifugation, whether we make use of artificial membranes (collodion, xanthate of cellulose) or of natural membranes (peach skin, the septum of egg shells).

These few data relating to solutions, salts and membranes, "taken by themselves," being ascertained, it seemed logical to study what would happen to the same elements considered in the living cell.

Doubtless the ideal thing would have been to isolate a cell.[5] Not being able to undertake this, I utilized homogeneous tissues (tubercles of potatoes) wherein the mode of functioning is essentially the same as that of a single constituent element, apart from the idea of quantity.

My researches proved that centrifugal force draws from the cells water, sugar, ferments; that this draft is produced in a constant manner and is never complete; that it not only modifies the density of the protoplasmic juices, but that it also produces variations of a physico-chemical nature.

Thus, while the striæ disappear from grains of starch taken first at the peripheral extremity[6] of a potato, tiny x-shaped hooks become apparent on the grains of the central extremity.

While very convenient for studying the phenomena of osmosis, these tubercles lend themselves poorly to experiments concerning the nucleus and the other noble parts of the cell; therefore I had resource to various tissues according to the cases under consideration.

The epidermis of the onion permits us to see without any difficulty the protoplasm carried away, then piled up by the centrifugation in the bottom of the cells, and the impossibility which is encountered of causing the disappearance of the Brownian movements, even by the most energetic forces.

The *Elodea Canadensis* provides an excellent field for the study of the chromoleucites, the more easy to be condensed the more hydrated the plant under examination.

Thanks to the Spirogyræ, we can easily note, according to the degree of speed employed, that the chromatophores are disturbed and then returned to position—that they can be definitely crushed—that they can be put into spheres—and that they can be finally dislocated into tiny elements very well individualized. These last, of ovoid form, more strongly colored at the two ends of their great axes, suggest chromoleucites which have been suddenly deprived of a sheath keeping them together but separated from each other.

From these few examples it is evident that centrifugal force acts upon true cells as it does upon solutions, salts and membranes. Let us see then whether it is also able to modify thoroughly systematized elements (sexual products, seeds, eggs).

In the course of my experiments I have discovered that:

1. The spermatozoa of the lower animals (*Ascaris*) support centrifugation perfectly, while those of the Mammiferæ are retarded in their movements.

2. Pollen, after a very long sojourn in a centrifugator, bursts in the midst of saccharine solutions, which are, however, favorable for the development of the control grains; but it is still capable of fecundating normal ovules without producing teratological types.

3. Centrifugated seeds lose weight, and their teguments become colored; and a very curious circumstance is that their germination is accelerated, retarded or arrested, according to the manner in which the centrifugation is applied.

4. The evolution of eggs is likewise hastened, made more slow or checked, and, finally, they yield a rather large percentage of parthenogenetic births.

I should like to call attention to many other details, but must confine myself to the main lines, for the further we advance in the series the more complex are the facts observed and the longer the description they require.

Before beginning the study of the phenomena produced by centrifugal force on adult animals it is advisable to examine how this force acts upon a very curious state of life: the nymphal period.

Rapid, but short, rotations produce chrysalids (*Bombyx*) cupped on the posterior side, whatever the orientation of the latter, letting them spout out a large quantity of liquid with respect to their weight, yet capable of living in spite of everything, and of continuing their evolution till the perfect insects appear.[9]

Slow and prolonged rotations act upon the duration of the chrysalid stage, which they either diminish or lengthen according to circumstances. I discovered also that the life of butterflies proceeding from centrifugated nymphs is shortened in proportion as the treatment is lengthened—and that their eggs, which are smaller and lighter in weight,[10] yield cocoons which are themselves modified.[11]

We now come to the disturbances sustained by adult animals through centrifugal force. While the Infusoria (green Paramecium, Vorticella), the worms (Convoluta Roseoffensis, Vortex, earthworm), the insects (chafers, Coccinella), undergo no alteration apparently, the fish begin to evince a certain torpor.

Beginning with the Batrachians the disturbances become clearly defined and vary with the orientation of the subject. My principal discoveries are the following:

Frogs centrifugated with "the head central" during one hour at 500 revolutions are still susceptible to violent excitations. Placed on their backs they remain there, allowing their limbs to remain as the operator places them, holding themselves in the water similarly to animals which have been curarized. Their cardiac contractions, of greatly retarded rhythm, show slight amplitude. On the contrary, subjects similarly treated, but with "the head peripheric," present gyratory motions in the direction opposite to that of the centrifugator;[12] much less influenced, they quickly return to the normal state. The beats of the heart are retarded and very ample. In both positions the teguments are red on the side where the force acts most energetically,[13] and there exists a sanguine concentration which may proceed to the extent of the drying of tissues.

With the mammals the phenomena are still more complicated. In order to study these I oriented the animals (rabbits, rats) in five ways:

1. Head in the direction of rotation.
2. Head opposite to the rotation.
3. Head peripheric.
4. Head central.
5. Head and tail peripheric.

My observations were as follows:

1. *In the first case* (head in direction of rotation) there exists, according to the periods considered, a conjugated deviation of the head and the eyes, movements of trunk, then a hemorrhage of the cerebellum, ending in death.

2. *In the second case* (head opposite to rotation) the disturbances are nearly similar to the preceding; only the direction of the movements of trunk differs.

3. If, after having been centrifugated in the position 1 during *n* minutes, it is immediately centrifugated in position 2 for *n* minutes also, a predominance of the first lesion over the second is perceived.

4. *In the third case* (head peripheric), as in the case of the frogs, the beats of the heart are amplified and retarded; the number of red corpuscles is increased; movements "like the hand of a watch" manifest themselves; death occurs through sanguine inundation of the metencephalon.

5. *In the fourth case* (head central) the subjects observed drag their posterior quarters, and upon autopsy exhibit a brain of waxy aspect.

6. *In the fifth case* (head and tail peripheric) the lesions are not, as one might believe *a priori*, the grouping of those obtained in the positions 3 and 4. There exists a conjugated deviation of the head and the eyes, a rocking or nodding of the head, an anes-

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[1]The ideas sketched in this article are developed in my *Contribution to the Study of Experimental Centrifugation in Biology*. (Thesis Doctor of Natural Sciences, published by Rey, 4 Rue Gentil, Lyons, 1917).

[2]As types of macrozymases we selected the luciferase and the purpurase of R. Dubois.

[3]For example: pellets of sulphate of copper and sugar immersed in a gelatinous solution of ferrocyanide of potassium.

[4]R. Dubois: Mineral Cultures: Radiobes and Eobes. C. R. Congrès de Liège, 1905.

[5]I do not as yet take into consideration monocellular organisms.

[6]The designation "peripheral extremity" of a centrifugated body is given to that portion of the said body which is farthest from the axis of the centrifugator, while its nearest portion is called the "central extremity."

[7]The plants issuing from seeds interrupted in their normal germination are but little modified histologically, but appear as if etiolated. Moreover they have very few absorbent hairs.

[8]Peripheric or central.

[9]These insects are stunted and are poor procreators.

[10]The differences of size and weight are much more perceptible when we examine the eggs born of parents centrifugated at the nymphal period for several generations.

[11]Those cocoons, which are smaller and shorter, are spun on the bare ground, and yield a lower percentage of females than of males. The evolution of the latter is more rapid than that of the former.

[12]These movements have nothing in common with the theory of "anti-kinesis." Cf. Raphael Dubois: The Natural Origins of the War. Georg, Lyons, 1916.

[13]This color is due simply to the dilatation of the capillaries.

thesia of the posterior quarters, and upon autopsy a slight congestion of the encephalon.[14]

I will make no report upon my timid attempts at human centrifugation, too incomplete as yet on account of the war,[15] but will point out, as briefly as possible, the alterations produced by centrifugal force in adult plants.

Suitably applied, this force modifies: the external aspect of a culture of Thallophytes, the size of the constituent elements and the activity of certain secreted products.

It is possible to sterilize sharp wines and damaged beers by simple centrifugation.

Finally, there is a very general idea which becomes evident from my investigations. This is that the more vigorous an organism is the denser it is. Thus a microbe, a diseased yeast are, for equal size, less heavy than a microbe or a yeast enjoying full physiologic activity.

With respect to experiments upon the superior plants it was found that the lots oriented with "peripheric roots" present a marked enlargement of the subterranean system as compared with the aerial portions, while those disposed with "central roots" cease to be subject to the action of geotropism, which is gradually annulled by the centrifugal force, as has been shown by Knight.

The ensemble of my investigations proves that the study of the effects produced by centrifugation belongs essentially to the domain of general physiology since in a number of cases these effects are comparable in both plants and animals.

We have seen that the centrifugal force violates the normal cellular equilibrium by activating the osmostic exchanges and by modifying the concentration of the juices; that it is capable of accelerating, retarding or preventing the development of eggs and seeds, of changing the weight and the size of certain organisms, and of occasioning disturbances capable of producing in living creatures internal or external anomalies.

But what is the reason for the manifestation of so many modifications? Is it because of simple pressure? Not only does a pressure exerted by other processes fail to give the same results, but the subjects thus treated will be destroyed. Besides the very special sort of pressure secured by the centrifugators another factor intervenes. Everything leads us to believe that we are here concerned with a case of dehydration, of drying of the tissues. In fact:

1. Organisms which are but slightly hydrated are not attacked by centrifugal force (the chafer, coccanella); those containing, on the contrary, a large percentage of water, are the ones most modified (Vertebrata).

2. Aquatic creatures centrifugated in their own element are not at all, or but little disturbed (Vorticella, Paramecium).

3. The butterflies of the *Bombyx* cannot pierce their cocoons in default of liquid to displace the threads.

4. The hyperconcentration of the blood, the increase in the number of red corpuscles, indicate the diminution of humor.

5. When sufficiently prolonged centrifugation desiccates frogs even more completely than the saline solutions employed by Claude Bernard.

6. The admirable investigations of Raphael Dubois long ago demonstrated the dehydrating action of general anesthetics. But in a series of experiments I have obtained a concordant between the results obtained by centrifugal force and by anesthetic vapors.

From all these facts it seems, therefore, to result that disturbances consequent on the centrifugation of living beings are due to two causes: the dehydration of the tissues on the one hand, and their compression (under a very special form) on the other.

State-Aided Research and the Small Manufacturer

SINCE the war started every one of the allied nations has come to realize how much they depended on Germany for a great number of manufactured articles. Because Germany sold these things at a low price, made possible by their syndicates and government assisted associations, we were willing to let them monopolize the business. This was further made possible by the clever propaganda, inaugurated years ago, for the manipulation of import laws and duties in such a way as to preclude the possibility of competition by manufacturers in other countries. The history of dye stuff tariffs in the United States is an excellent example of German intrigue of this nature. Now these monumental blunders are being realized, and strenuous efforts are being made in every country to win commercial freedom, at the same time that our armies are fighting for political freedom.

In England systematic efforts are being made in this direction, and a report of the British Committee for Scientific and Industrial Research, extracts of which are given below, as published in the *Journal of the Society of Chemical Industry*, should be of wide interest in the United States:

Although adequate provision has been made for the prosecution of investigations of pressing national concern, such as those on fuel, timber and concrete, the spade-work of the past year has been largely concentrated on the organization of cooperative industrial research, for which purpose there has been established a fund of £1,000,000 to be expended over a period of five or six years as grants in aid to Research Associations, the maximum grant to any one association not to exceed the total of the contributions of its constituent firms.

In addition to the two classes of research above mentioned, the national and the cooperative, there is a third class which covers the work of individuals and of independent manufacturers; and it is in respect of the last-named that criticisms and complaints have begun to appear. No definite or satisfactory scheme, it is said, has been devised for helping the small, independent manufacturer by means of monetary grants, or by relief from taxation; and in many cases, the incidence of the excess profits tax has fallen upon him with such severity that research work has had to be postponed or abandoned. The larger firms which have joined a Research Association have been allowed their contributions to it as a working expense for the purposes of income tax, excess profits and war profits taxes: why should not the same privilege be allowed the manufacturer who prefers to "gang his ain gait," or is compelled thereto, owing to lack of facilities for cooperation? Surely the State does not wish to cripple the independence or initiative of the individual manufacturers to which British industry has owed so much in the past?

Before proceeding to discuss these claims, it would be well to consider first what the committee has to say upon the subject. On the general question of cooperative *versus* individual action, the report is very definite. "It is intended that the Research Associations should include as many of the firms in each industry as possible" (p. 12). Notwithstanding the fact that under the heading "Researches unsuited for Cooperative Action" only far-reaching problems of national importance are specified (p. 15), we read on the next page that there is room for private research by individual firms on the lines of their own special work, and they may gather many suggestions for this from the results of the cooperative investigations. No attempt is made to distinguish between work best fitted to be performed inside the works, and that to be done outside a subject—of no small importance. Research by the individual firm is further referred to as being undertaken "at its own expense."

Reference to the position of firms which do not participate in the new scheme of cooperative research is to be found in two paragraphs at the end of the report (pp. 44 and 45). The cooperative associations are expected to be very useful to their constituent firms in helping them to solve difficulties encountered in the course of manufacture, "but it will take time for all the many industries of the country to organize themselves, and meantime, we shall do our best to assist inquirers to obtain the best advice available." In those cases where the problem has a *prima facie* connection with research, the Royal Society will assist the committee in selecting an institution, or research workers, to carry out the investigation. In suitable cases, the committee will formulate the problem to be investigated, and will pay for the services of an assistant if required. If the work proves successful, the manufacturer will be asked to pay for either the whole or a part of the expenses incurred, and in return he will have the exclusive benefits of the research "for a period to be agreed upon." An alternative method of assistance is also foreshadowed. A "young" research worker may be attached to the works laboratory for a definite period, during the first term of which the department would pay the whole of his salary, during the second period it would pay a moiety, and during the third and last the manufacturer would bear the whole expense.

There is thus, apparently, no intention of assisting the unattached manufacturer by means of grants in aid, nor of helping him by allowing the costs of research to be paid for out of excess profits; but the general tenor of the report, and the brevity of the allusions to this part of the subject, lead to the inference that the question is still under consideration, and that the committee is open to revise any of the tentative conclusions it has arrived at.

Although no kind of combination between manufacturers other than that for the purpose of research is mentioned or implied, the small manufacturer who looks with repugnance upon the development of cartels, trusts and other forms of combination will probably see in this advocacy of cooperative research merely the thin end of a wedge which, if driven further, would lead to his ultimate extinction as an independent unit. He might further argue that the facilities for cooperation in research possessed by the larger firms, such as those engaged in the "heavy" chemical industry where fusions and "understandings" have been multiplying of late, are undoubtedly greater than those which are at present available to him, and that, pending the solution of the very difficult problem of organizing the small manufacturers, he should at least receive an equal measure of State recognition. The carrying out of his researches at an institution, probably remote from his works and over which he would have but little control, or the atttachment to his laboratory of a research worker, who, being specified as "young," would probably lack experience, would not satisfactorily meet his needs; and even if he were permitted to allocate the costs of research to working expenses for the purposes of taxation, he would still be at a disadvantage compared with his "combined" rival, inasmuch as he would not have at his disposal the well-equipped organization of a cooperative association. To the unattached manufacturer, who has either been unable to initiate research work, or has been forced to abandon it from pecuniary considerations, the retort might be made that if he had invested in research before the war the cost of it could now be included in his working expenses, and that his present dilemma is but a consequence of his previous neglect or want of foresight; such an argument, however, would come badly from a State department, whose primary object is to encourage research, here and now. Nor does the contention that the revenue must be protected appear to carry any great weight, for much of the research work in question would have some national importance, and judged with reference to current expenditure, the sum involved would be very small.

In answer to the objection that if chemical manufacturers were assisted in the manner described a multitude of other manufacturers and traders would present similar demands, the reply could be made that each application should be considered on its merits, the main criterion being that the work for which aid was sought should be of distinct national importance. Assuming now that the principle of direct financial assistance were ceded, it would yet remain to devise a workable scheme of applying it. The report seems to suggest that the small manufacturers should join existing associations, but it is obvious that in many cases this would not be possible, and it would therefore be necessary to form new associations. The organization of these would be a formidable task, as the manufacturers themselves would be too fully occupied to devote the necessary time to it, and the selection of properly qualified State officials would be no less difficult, even if the officials as such were acceptable to the manufacturers. An alternative plan would be to allow a certain percentage of the excess profits to be expended upon research, the magnitude of which would vary inversely with the pre-war standard of profits, the maximum percentage being allowed to such firms which had no pre-war standard at all. A third method would be to make direct grants in aid, to vary in amount according to the needs of the individual firms. Such a proposal would involve a large amount of investigation work on the part of the department, and it is doubtful if the manufacturer would be willing to submit to such an ordeal.

The second plan seems least open to objection, but the whole question is beset with difficulties and needs very careful consideration. From a cursory survey of the arguments for and against, we incline to the view that the small independent manufacturer has a good case for greater assistance than that promised or adumbrated in the report; at the same time, the underlying principle of the committee's proposals—cooperation for the common weal—admits of no refutation.

[14] Of course we observe, besides the disturbances noted, a whole series varying with the degrees of speed employed and the length of time. The animals return to their normal state unless there is a systematic endeavor to produce death.

[15] The appartus employed, being of German origin, was sequestrated at the beginning of the mobilization.

The Old-Time Treasure Chest*

One Recently Discovered Throws Light on Contemporary Methods of Iron Manufacture

By Alexander E. Outerbridge, Jr.

In ancient times, before the days of banks and safe-deposit vaults, the care of valuables, such as specie, gold and silver plate, jewels, deeds, wills and precious articles of various kinds, caused much anxiety at times to their owners from the fear of robbers and danger of fires.

When persons of wealth started upon long journeys in olden days, either by land or sea, the care of their gold and silver money and other valuables was indeed a serious matter; the anxieties of travel were greatly enhanced by the difficulty of insuring safe transportation of such treasures.

This caused a great demand for the making of "strong boxes," as they were called, the predecessors of our modern burglar and fireproof safes. These boxes, also called "treasure chests" (French "coffres") resembled small-sized trunks in shape. They were sometimes made of heavy plates of wrought iron, welded together and reinforced with many broad bands of iron, crossing and recrossing, securely fastened with scores of round-knobbed rivets; they had strong, twisted iron handles and two men were needed to lift one of these boxes even when empty, and when filled with coins, jewels and silverware, four strong men were needed to handle them.

Great ingenuity was displayed in the design and construction of the locks, which were massive and complicated. The huge keys were forged by hand from wrought iron and often weighed 30 or 40 times more than a modern Yale lock key. Highly skilled artisans, or workers in metals, produced these hand-wrought treasure chests, and even though such labor in those days was cheap the cost of these boxes was considerable.

Very recently, while strolling through an out-of-the-way and rather unattractive section of Philadelphia, along a street lined with dingy shops displaying cast-off garments, half-worn shoes and old furniture for sale, the writer's attention was attracted by noticing on the sidewalk an unmistakably genuine treasure chest such as we have just described. The strong box was very rusty and bore evidence of having been buried for a long time in the ground. The proprietor of the little second-hand furniture shop proved to be an intelligent young man, a motorman doing night work and adding to his income by buying up old furniture, which his wife sells. The story he told regarding the box was quite interesting and will be given in his own words as nearly as may be possible. He said:

"Ye said chest to be locked with three severall lockes at ye least, which shall be kept by three of the said ffeoffes"
Old English Guild's Book

"I heard the other day that a very old lady living in the northwestern part of this city was breaking up housekeeping and was selling all of her possessions. When I went to the house the old lady was seated beside this iron chest, busily engaged in tearing up letters and papers with which the box had apparently been filled. She had destroyed all save one old newspaper in the bottom of the chest, which I fortunately secured. She told me she was the last of her tribe and meant to leave nothing behind her, and that she knew that the box had been in their possession for much more than a century. I bought the box and brought it here not half an hour ago. The old newspaper, dated July 10, 1805, is still in the box, and I suppose you might like to see the inside of the chest."

The young man then produced a massive iron key and suggested to the writer that he try to discover how to unlock the chest. There is an ornamental "escutcheon" on the front, with a large keyhole in the center, into which he inserted the key, but it soon became evident that this was merely a sham intended to deceive any thief who might have surreptitiously obtained possession of the key. There was no connection with the lock here.

After careful examination it was noticed that a slot had been cut in one of the bands on the top of the chest 3 in. long by 1 in. wide, and a piece of iron was carefully mitered or fitted into the opening. There was a large round rivet in the middle of the inserted piece, and a little notch was cut on the underside of the rivet; by inserting the fingernail in this notch and pulling gently, the piece sprang up, having been held down by a spring, and it could then be swung around revealing the true keyhole. On inserting the key, and giving it a half turn, five bolts, which are operated independently of each other by strong springs, shot back, permitting the lid to be raised.

The lock is an elaborate piece of mechanism, occupying the entire underneath side of the top of the chest, and it is in a perfect state of preservation. It is covered with a perforated metal plate, apparently coated originally with silver, and having engraved upon it two winged dragons with forked tails, possibly armorial bearings. Notwithstanding the fact that the exterior of the chest is badly rusted the interior is quite free from corrosion.

Since its discovery and purchase by the writer this old iron chest has been critically examined by scores of mechanics, skilled workers in iron and steel, and one and all unite in praise of the skill shown in its manufacture, entirely by hand work, as well as of the ingenuity displayed in the design and construction of the great lock and key. Counting two padlocks, there were actually three different locks and nine separate fastenings on the chest. It is truly remarkable that after certainly more than a century, and probably more than two centuries, of use and exposure, the lock should be in as perfect condition today as when first made. This speaks volumes for the care and skill of the artisans who fashioned it so long, long ago.

Eventually the old strongbox may find a resting place in a museum, but in the meantime it will serve as a woodbox for the open fireplace in the writer's library.

Several inquiries have come to the writer since he prepared a brief account of the discovery of this "coffer" for a Philadelphia newspaper, asking further particulars.

The answer to these questions required considerable antiquarian research, which, for a time, seemed almost like searching for a needle in a haystack, but it has, nevertheless, proved successful in finding some interesting data relating to the state of the art of iron manufacture and metal-working in general, and the production by handcraft of treasure chests in particular at or near the time it is thought his coffer was made.

Searching in several public and private libraries, the writer fortunately found a number of rare and valuable old books on arts and sciences on the shelves of the Franklin Institute, Philadelphia, which are probably but little known to the engineering profession or to the public at large. One of these books, having the autograph "B. Franklin," in his familiar handwriting, is considered so precious, partly on this account, that it is always kept locked in a fireproof safe. This work bears the title: L'Art de Convirtir le Fer Forge: En Acier et

*Courtesy of *The Iron Age*.

A—Hearth. B—Heap. C—Slag-vent. D—Iron mass. E—Wooden mallets. F—Hammer. G—Anvil.

One of the illustrations from Agricola's great work as translated by Herbert C. Hoover and his wife

A—Forge. B—Bellows. C—Tongs. D—Hammer. E—Cold streak.

Another illustration from Agricola's famous book as translated by Mr. and Mrs. Herbert C. Hoover

L'Art D'Adoucir le Fer Fondu. The author is Monsieur Reaumur, of the Royal Academy of Sciences, and it was published in Paris in 1722 "Avec Approbation et Privelege du Roy."

It may probably surprise the readers of this article, as it certainly did the writer, to learn that a magnificent folio volume, a translation of the first Latin edition, 1556, of "De Re Metallica," by Georgius Agricola, containing hundreds of footnotes and cross references, revealing a vast amount of scholarly research, was published in London in 1912, by Herbert C. Hoover and Lou H. Hoover. Since that time Mr. Hoover has attained world-wide celebrity for his philanthropic work in Belgium and in this country, exhibiting a genius for organization that is not usually looked for in a classical scholar.

Two of our illustrations are photographic reproductions of two of the original illustrations from Agricola's great work. Another monumental work consulted, from which one illustration was taken, is an Encyclopædia of Arts and Sciences, in 34 large volumes, in the French language, the first volume bearing the date 1751.

Twenty-two of these volumes are text and 17 are splendid copper-plate engravings. The lack of an index, however, necessitated searching through all of these volumes, but the writer was finally rewarded by finding a chapter on "Coffres" or iron treasure chests, and several plates showing not only the construction of a coffer, with its elaborate lock, occupying the whole of the underneath side of the lid, and of various details, but also plates showing padlocks and a great variety of keys, handles and escutcheons made for these strongboxes.

Still other illustrations show the old methods of laminating iron bars, bands and plates, forging rivets, angle irons, etc. The elaborate title page states that this encyclopædia of the arts and sciences has been prepared by a coterie of men of letters, and has been arranged in order and published with the approbation and privilege of the king by M. Diderot of the Royal Academy of Sciences of Paris, and a long list of other learned societies. The mathematical portion is by D. Alembert, also a member of numerous societies. The date is MDCCLI.

The monumental work of Georgius Agricola was translated into several languages years ago, but nothing approaching the completeness and doubtless accuracy of the Hoovers' superb production has heretofore appeared. A copy of the title page will serve to give the reader some idea of the scope of the original work and of the labor of love of the erudite translators, but of course this does not show the really splendid book work, typography, paper and binding of this edition de luxe, which should be found in every important library.

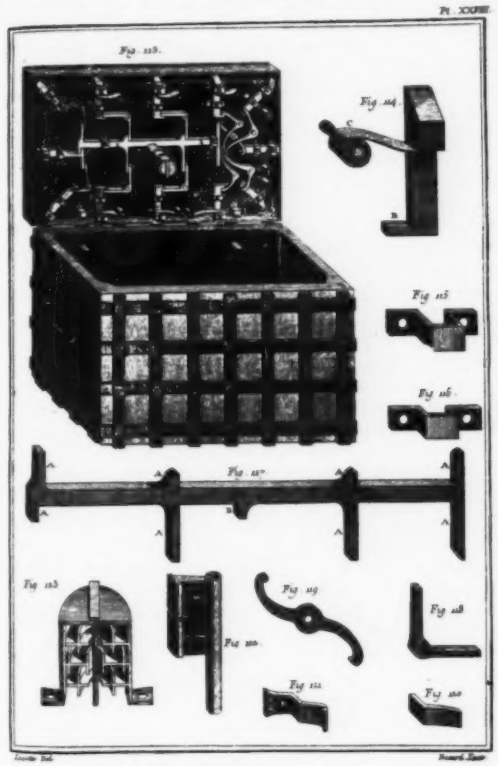
"GEORGIUS AGRICOLA DE RE METALLICA

Translated from the first Latin edition of 1556 with biographical introduction, annotations and Appendices upon the development of mining methods, metallurgical processes, geology, mineralogy and mining law from the earliest times to the 16th century. By Herbert Clark Hoover, A.B. Stanford University, member American Institute of Mining Engineers, Societé des Ingenieurs Civil de France, American Institute of Civil Engineers, Fellow of Royal Geographical Society, etc., etc., and (Mrs.) Lou Henry Hoover, A.B. Stanford University, member American Association for the Advancement of Science, National Geographical Society, Royal Scottish Geographical Society, etc., etc. Published for the translators by *The Mining Magazine*, Salisbury House, London, E. C., 1912."

The following excerpt from the Hoover translation will suffice to show clearly the primitive method of reducing iron ore to regulus or the metallic form in the sixteenth century, and, incidentally, it is interesting to observe that gas masks were used even at that day:

"Very good iron ore is smelted in a furnace almost like the cupellation furnace. The hearth is 3½ feet high and 5 feet long and wide; in the center of it is a crucible 1 ft. deep and 1½ ft. wide, but it may be deeper or shallower, wider or narrower, according to whether more or less ore is to be made into iron. A certain quantity of iron ore is given to the master, out of which he may smelt either much or little iron. He, being about to expend his skill and labor on this matter, first throws charcoal into the crucible and sprinkles over it an iron shovelful of crushed iron ore mixed with unslacked lime. Then he repeatedly throws on charcoal and sprinkles it with ore, and continues this until he has slowly built up a heap; it melts when the charcoal has been kindled and the fire violently stimulated by the blast of the bellows, which are skilfully fixed in a pipe. He is able to complete this work sometimes in eight hours, sometimes in ten and again sometimes in twelve.

In order that the heat of the fire should not burn his face, he covers it entirely with a cap, in which, however, there are holes through which he may see

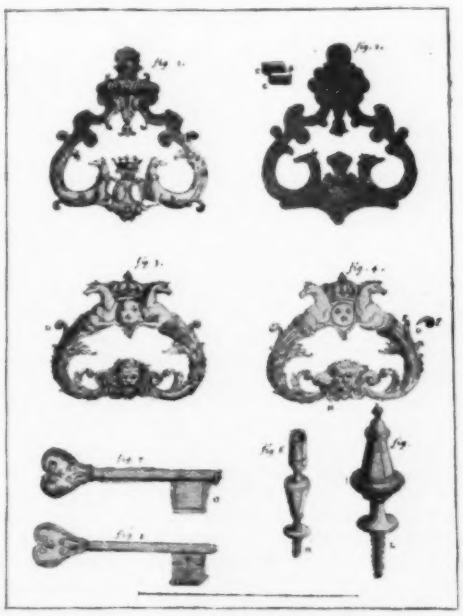


Details of locksmithing lock of ancient coffer having twelve bolts

Fig. 113, strong coffer with lock. Fig. 114, one of the bolts. A-A, chamfered head; B, the heel, C, spring on roller. Figs. 115-116, hold-fasts on bolt nabs of lock; Fig. 117, large bolt A-A; the barb, B; Fig. 118, one of the knees; Fig. 119, the rocking lever; Figs. 120-121, staple and clutch; Fig. 122, the key, and Fig. 123, box containing wards for the key. These details are from a page in an encyclopædia of arts and sciences of 34 volumes, the first dated 1751.

and breathe. At the side of the hearth is a bar which he raises as often as is necessary, when the bellows blow too violent a blast, or when he adds more ore and charcoal.

He also uses the bar to draw off the slags or to open or close the gates of the sluice through which the



A copper plate from an ancient book which shows the various parts of an old chest, similar to the one just discovered

waters flow down on the wheel which turns the axle that compresses the bellows. In this sensible way iron is smelted out and a mass weighing two or three *centumpondia* may be made, providing the iron ore is rich. When this is done the master opens the slag-vent with the tapping bar and when it has all run out he allows the iron mass to cool. Afterward he and his assistant stir the iron with the bar and then, in order to chip off the slags which had until then adhered to it and to condense and flatten it, they take it down from the furnace to the floor and beat it with large wooden mallets having slender handles 5 ft. long. Thereupon it is immediately placed upon the anvil and repeatedly beaten by the large iron hammer that is raised by the cams of an axle turned by a water wheel. Not long afterward it is taken up with tongs and placed under the same hammer and cut up with a sharp iron into four, five or six pieces, according to whether it is large or small. These pieces, after they have been re-heated in the blacksmiths' forge and again placed on the anvil, are shaped by the smith into square bars or into ploughshares or tires, but mainly into bars. Four, six or eight of these bars weigh one-fifth of a *centumpondium*, and from these they make various implements. During the blows from the hammer by which it is shaped by the smith a youth pours water with a ladle onto the glowing iron, and this is why the blows make such a loud sound that they may be heard a long distance from the works. The masses, if they remain and settle in the crucible of the furnace in which the iron is smelted, become hard iron which can only be hammered with difficulty. From these they make the iron-shod heads for the stamps and such like very hard articles."

In an explanatory footnote the authors say that in the description of iron making we have three processes described, the first being the direct reduction of malleable iron from the ore, the second the transition stage then in progress from the direct to the indirect method by way of cast iron; the third a method of making steel by cementation. The first method is that of primitive iron workers of all times and all races, and requires little comment.

A pasty mass was produced which was subsequently hammered to make it exude the slag, the hammered mass being the ancient bloom. The second process is of considerable interest, for it marks one of the earliest descriptions of working iron in a furnace similar to a blast furnace, but much wider and higher. This original German stückofen or high bloomery furnace was used for making masses of wrought iron under essentially the same conditions as its progenitor the forge, only upon a large scale.

With high temperatures, however, such a furnace would, if desired, yield molten metal and thus the step to cast-iron as a preliminary to wrought iron became very easy and natural; in fact, Agricola mentions above that if the iron is left to settle in the furnace it becomes hard. The making of malleable iron by subsequent treatment of the cast iron—the indirect method—originated about Agricola's time and marks the beginning of one of those subtle economic currents, destined to have the widest bearing upon civilization.

With regard to the history of treasure chests, the Encyclopædia Britannica states that, "Although it is practically certain that boxes or coffers, provided with locks, must have followed closely on the development of locks and have been in use in ancient Egypt, no examples remain of earlier date than the Middle Ages. The earliest examples extant were constructed of hard wood banded with hammered iron and subsequent development took place rather on artistic than on practical lines up to the time of the introduction of boxes entirely of iron. On the continent of Europe the iron box was developed to a very high standard of artistic beauty and craftsmanship, but with no real increase in security.

Several specimens of these coffers, supposed to be of 17th century workmanship, are preserved in the museum at Marlborough House. Cast-iron chests seem to have been made in various parts of Great Britain in the early part of the 19th century, but the use of wrought iron was probably confined to London until 1820 or thereabouts, when the trade spread to Wolverhampton. Nelson's Encyclopædia says:

"German and Flemish chests were constructed of small iron plates, riveted together by overlapping bands of iron, and their lids were fastened down by staples and padlocks; the inside of the lid was covered with spring bolts shooting out in all directions and worked by means of bell cranks, levers and rods from a central lock having a box of wards."

The most elaborate book in the English language upon this special subject is entitled:

"Ancient Coffers and Cupboards"—their history and description from the earliest times to the middle of the sixteenth century. By Fred Roe.

The author says:

"Two ancient and exceedingly interesting specimens of the iron-bound strong box remain in the chapel of the Pyx at Westminster. This chapel, the ancient

treasury of England's kings, is little known, and access is even now jealously guarded. At the beginning of the fourteenth century while Edward the Lion was busy hammering the Scots, a strange and mysterious robbery caused the translation of the royal treasury to a more secure place. One hundred thousand pounds in English money alone is said to have disappeared, besides jewelry and plate. The theft to this day remains a mystery."

The treasure chest in Pyx chapel said to have belonged to Edward III is fitted with triangular handles on back and front, and at the ends are rings depending from movable bars. When required for purpose of transport, a pole would be passed through these rings and the coffer would be slung across the backs of two mules. "This attachment is really an early feature, and may be seen on an undoubted thirteenth century coffer in the Museum of Ypres."

The chest shown in the photograph is constructed of an exceedingly strong wrought-iron framework with wrought-iron plates riveted thereto, apparently two or more plates superimposed, reinforced with broad bands of iron, neatly pressed, and there are 220 large and small rivets visible, but there are more rivets that could be seen only by taking the box apart.

The steel of the springs is of very excellent material, combining strength and elasticity to an unusual degree. No name has been found engraved upon the ornamental plate covering the lock, and it is not possible to fix the precise date of its manufacture, but other similar treasure chests, having precisely the same form of lock and ornamentation closely resembling this one, are still preserved which are classified as "Elizabethan treasure chests," dating back to about 350 years ago, and it would seem probable, therefore, that this old box belongs to the same period.

Note.—Since the publication of this article several old treasure chests in this country have been brought to the attention of the author. One is owned by the Chemists Club in New York bearing date 1423; the Historical Society of Philadelphia has two in its collections, one that belonged to Robert Morris, financier of the Revolution, and the other to James Hamilton. The family of Mr. J. G. Rosengarten of Philadelphia has two, which were brought over about 1635. Two others have also been located, and it is probable there are still others in this country.

Hydro-Electric Development*

BEING empowered, as it is, to speak for the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, on matters of common concern to all these bodies, Engineering Council's official utterances concern only such underlying principles and economic facts as are endorsed by all engineers and beyond the field of controversy. These societies are scientific and professional. They, therefore, refrain from expressing views on legal, political and commercial questions, except when such are closely linked with essential engineering facts. The statements which I am privileged to make to you are not expressions of my personal views, nor of those of any group. They have been submitted to, and approved by, the executive committee of engineering council which believes them to fall within the definition given.

"The introduction of electricity as a means for transmitting power over considerable distances, and its subsequent rapid development, completely changed the status of hydraulic power. Previously such power could only be used near falling water. Now it is commercially available in convenient form within a radius, in some instances, up to 200 miles, a fact that has made it possible to utilize water powers even when located in remote and inaccessible places. Indeed, today practically all hydraulic power developments of any magnitude are hydro-electric. Along with improvements in the art of electrical transmission have come equally rapid developments in the application of electricity. Electric light has become almost the universal illuminant. Electric motors largely drive our factories and propel all our street cars. They have made substantial progress in replacing steam locomotives on some large railroads, while the manufacture of nitrogenous products for explosives and fertilizers, and of such products as abrasives and aluminum, depends for its commercial success on electro-chemistry. In an endeavor to supply the demand for electric current thus created, large central generating stations have been established in or near all large centers of population.

"In the light of the foregoing, it might seem reasonable to suppose that a large proportion of the modern demand for electric current would be supplied from the energy in falling water. Such, however, is not the case. Accurate statistics are difficult to obtain, but some approximate totals may prove illuminating. It has been estimated by a careful engineer that in 1911 there was more than 26,000,000 steam-engine horsepower capacity in use (including railroad locomotives) in the United States. The aggregate water horsepower developed and undeveloped has been computed as around 60,000,000. Of this latter, the U. S. Census of 1912 gives 4,870,000 as developed, and, in a report of January, 1916, the Secretary of Agriculture estimates this total to have been increased to 6,500,000. Making liberal allowances for correction in these several figures, it seems probable that there are in service from four to five times as many steam as water horsepowers, and that there are still undeveloped water horse-powers equal to at least twice that of all the steam capacity in service. Some of the undeveloped power sites are too remote from any market to be now utilized, and an uncertain number are not commercial prospects; but, even so, it is clear that the possibilities of additional development are very great.

"There are two fundamental causes which have militated against the substitution of hydro-electric for steam-electric power. One is economic and permanent; the other is statutory, and therefore subject to modification. Both reasons apply to some powers, but neither, fortunately, to all. The economic and permanent reason is high cost of development due to natural conditions. Electric power generated by falling water is inferior to that generated by steam in every particular except cost, and, therefore, water-driven service must be cheaper than steam-driven, in order to justify its existence. The price for service depends primarily on cost, and cost divides itself naturally into two main items, namely, operation (including maintenance), and fixed charges. As an hydro-electric plant consumes no fuel, its operating cost is less than that of an equivalent steam-driven plant. On the other hand, a steam plant costs usually only from one-fifth to one-half as much per unit of capacity as an hydro-electric plant; so that the latter must carry very much heavier fixed charges. This disability of water service is usually even greater than the ratio of the costs of two equivalent complete developments. A power enterprise seldom comes into being with a market for its entire ultimate output. Therefore, when steam is to be the motive power, only such capacity is installed as initial demands require, and the cost per unit is fairly proportional to that of the ultimate development. In a water development, on the contrary, a larger part of the cost is for riparian rights, for the dam, impounding reservoir, flume, forebay, etc., and for the transmission right of way, towers, etc., which must be, at the start, largely provided and constructed for the complete installation. The obvious result is a greater fixed charge per unit of capacity and a higher cost per horsepower delivered for sale. In forecasting the commercial prospects of a power enterprise, the possible market must be studied, and, of course, a sale price for power decided upon. As this price is controlled by the cost of similar service from other sources, usually from steam, and as it must be attractive from the start, the additional burden of fixed charges on the initial part of an hydro-electric installation frequently forces the sale of its power below cost. The projectors of the enterprise then must rely for success on a sufficient subsequent increase in their markets. The possibility of an incorrect forecast of the extent of such increase and of the time when it may come imposes a serious business hazard against water and in favor of steam.

"It has been frequently pointed out that, as the nation's coal supply is depleted, the cost of coal must rise, thus increasing the cost of steam-electric power as a competitor and raising the market value of hydro-electric power accordingly. The rising price of coal is a matter of record, but it is not so generally known that the improved efficiency of steam-producing machinery (boilers, engines, generators and auxiliaries) has more than kept pace, so that the net cost of producing electric power from coal has steadily declined. As applied to the pre-war period, it may be stated that, over a period of 10 years, the cost of coal has risen on an average 1% per year, while the cost of electric power produced from coal has fallen on an average 2½% per year. In addition to these facts—still referring to pre-war conditions—the cost of steam-electric generating equipment has been greatly reduced. This fact is due partly to the introduction and subsequent improvement of the steam turbine, and in part to the great increase in the size of the units now available. There is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached, or is even in sight. It is, therefore, a reasonable assumption that further advances in the art will continue to occur and to cut down both the fixed charges and the operating cost of steam power as a competitor of water. The largest modern steam turbine has now some twelve times the capacity which the largest reciprocating engine had 15 years ago. Stated another way, the cost of a steam-electric plant per unit of capacity just before the war was about one-third of what it was 15 years previously, while the energy it produces per pound of coal has increased 50 per cent. In addition to the development of steam prime movers, the Diesel or the internal combustion engine is now coming largely into use as a further competitor of water power where fuel oil is available, as in the southwestern district of the United States. The efficiency of these engines is considerably higher than that of the small-size steam turbine and reciprocating engine. There has not been a like improvement in the efficiency, nor a comparable reduction in cost, of the small reciprocating steam unit, and a natural result has been the expansion of central stations. As bearing on the water-power situation, obviously many sites which 15 years ago might have been developed to sell energy in successful competition with steam at its then cost could not now be so developed, and in consequence their development is no longer commercially possible. The cost of producing power from either water or steam is a function of load. Fixed charges remain practically unchanged in both instances, whether the output in energy be large or small, but with a steam plant, increased output means increased fuel consumption, while a water plant operates, either with or without load, with but little variation in expense. To illustrate by a concrete example representing not unusual conditions, suppose we assume a steam plant using 2½ lb. of coal per kilowatt hour at a price of $3.00 per short ton, and having a plant or output factor of 35%—that is to say, an output equal to 35% of its theoretical output if every unit were loaded to capacity 24 hours each day of the year. Under these assumptions, the cost of fuel per unit of installed capacity per year would be $11.50, and if the other operating and maintenance charges be assumed to offset fairly those of a water installation of equivalent size, $11.50 represents the additional fixed charges which the hydro-electric plant could carry and produce power at an equal cost. If the fixed charges (interest, taxes, insurance and amortization) total 11½%, therefore, the hydro-electric investment per kilowatt capacity could exceed that of steam by $100. This is not an abnormal excess. Many hydro-electric developments exceed the cost of equivalent steam-driven systems by much greater amounts, in which cases they become commercial projects only if either coal be more expensive per unit of output, or the plant factor be higher, or some other operating or maintenance conditions be more favorable. Further, as has been previously stated, hydro-electric power is inferior to steam-electric power. The reasons are elementary. Stream flow is subject to seasonal variation, and therefore to complete or partial interruption by drought in summer and by ice in winter. Floods are a menace. Long transmission lines may break, from wind or sleet, or the service be disarranged by lightning. The losses on such lines vary with load, and are frequently responsible for annoying pressure variations. On account of these and other reasons, hydro-electric power cannot prevail against steam competition at the same or a slightly lower price. It must be materially lower.

"We do not mean to imply that water power may not be a commercially practicable competitor of steam. Many successful hydro-electric installations give substantial proof to the contrary. We do wish most emphatically to combat, however, the widely held but mistaken view that any water-driven plant will produce power at lower cost than steam can, and that the margin is so large that investors generally are eagerly seeking a chance to put money into hydro-electric projects. The most careful investigation, frequently demanding substantial expenditure and the keenest scrutiny by experts, is needed to discriminate between worthy and commercially impracticable projects, and the difference is often so small that the imposition of even what seem to be minor burdens is sufficient to turn the scale in favor of steam and entirely prevent what might otherwise be a desirable hydro-electric development.

*Statement submitted to a special committee of the United States Chamber of Commerce, January 14th, 1918, on behalf of Engineering Council, by Calvert Townley. Republished from the Proceedings of the Am. Soc. of Civil Engineers.

"The second condition which vitally affects development is statutory. After 10 years or more of discussion it has come to be generally agreed that our Federal laws discourage the development of a large proportion of the nation's water powers, and remedial legislation has been considered at every session of Congress for many years. The legal obstacles are quite distinct and separate from the economic facts which have been previously described, and are in addition thereto.

"Of the estimated 55,000,000 undeveloped water horsepower in the entire country, approximately 40,000,000 is located within the boundaries of the thirteen so-called Western water-power States. In these same States the Federal Government still retains as proprietor 760,000,000 acres, or more than two-thirds of the aggregate acreage of all these States taken together. In order to develop power in that section, it is, therefore, nearly always necessary to use some part of this public domain, if not for the dam site itself, at least for flowage, for transmission right of way, or for some other purpose. Existing law forbids such use except under permit issued by the Secretary of the Interior, and revocable without cause, at any time, by himself or his successor in office. It was once believed that revocation would only follow gross abuse, well established by evidence, but the drastic action of a one-time Secretary of the Interior, some years ago, to the contrary, disabused investors of this confidence, and demonstrated by a sad object lesson the insecure tenure afforded by existing law. As funds for hydro-electric development must come from private sources, the unstable tenure imposed by this condition has constituted so great a hazard of loss that the private investor has been loath to assume it. The unfortunate—almost disastrous—result has been practical stagnation in water-power development for many years. Many available power sites, not in the Western States, or not on the public domain, are on navigable streams. For each such project a special Act of Congress is necessary. The difficulty of obtaining suitable rights by this means has been found so very great as largely to discourage, even if not entirely to prevent, the developments affected. The several remedial laws recently considered by Congress recognize the essential facts, and agree that the remedy is a new law containing the following provisions, namely: An indeterminate permit, irrevocable during 50 years, except for cause judicially determined, and continuing thereafter unless and until the Federal Government either renews its permit on mutually agreeable terms, or for itself or through a new permittee, takes over, at its fair value, the hydraulic works and certain other parts of the development. The various proposed laws differ as to what parts of the development may be taken; as to whether or not rentals shall be paid, and their basis, and in many other particulars. Engineering council does not consider itself expert in legal matters, and will not undertake to discuss the relative merits of the different plans. It should be pointed out, however, that an hydro-electric enterprise, being once successfully established, it is alike to the interest of the owners, of the Government, and of the public, that it should continue indefinitely without interruption. There is no economic reason to be served by a cessation, and the only reasons for providing a legal means of recapturing the installation and the water rights are, first, to preserve an additional measure of Government control against possible abuse by the permittee, and, second, against a remote contingency which might make it desirable that the Government would want to use the power for some other purpose. A successful power enterprise at the end of 50 years will have multiplied the capacity of its initial installation many times, variously estimated at from five to twenty. In doing so, it is almost certain that, not only will the entire power available at the original site be fully developed, but other powers as well, which latter may or may not be dependent upon Government permits. Still further, in nearly all cases, steam plants as well as water plants are necessary. These steam plants are necessary to supplement hydro-electric power at period of low water and in case of interruption, as well as, in some instances, to provide increased capacity. In fact, modern practice is rapidly approaching that of providing steam capacity equal to 100% of hydro-electric for the purposes stated. In any event, the growth of the enterprise over a term of years will be continuous and progressive. There will never come a time when it may be said to have been completed and subject to no further expansion. This continuing growth makes burdensome and usually abortive any attempt to amortize the investment, while the investment in other water powers or in steam plants or both, interconnected with, and generally dependent for their economic operation on, the original development, renders the right to recapture that development only very onerous, and one which constitutes a serious impediment to the free and full development of an enterprise which is otherwise most desirable from all standpoints. With respect to power sites on the public domain and on navigable streams, the Government is in the position of seeking to have its resources developed without assuming any business hazard and without contributing either capital or credit. It would be unfortunate, in the light of past experience, if any new laws which may be enacted should put the Government in the position of bargaining with capital and of offering just sufficient incentive not to induce capital to undertake the developments desired, thereby, while apparently providing a remedy, in reality insuring a continuance of the present undesirable condition. Hydro-electric enterprises must compete with the demands of other industries for capital. Experience has shown that, even without the imposition of additional financial burdens, many of them are not sufficiently attractive to secure development, and, as the attractive prospects grade by imperceptible degrees into the unattractive ones, it is perhaps self-evident that every additional burden, however small, transfers a percentage of such projects from commercial into uncommercial prospects. It is our belief that the benefits afforded the communities served by cheap power, and to the nation by the conservation of coal resulting from the substitution of a self-renewing for a non-renewable natural resource, are far more valuable than is the exact solution of the question of restricting the returns to capital to their irreducible minimum point. The present emergency, due to the progress of the war, has forcibly illustrated the importance of having developed the greatest possible number of water powers as a source of industrial power supply. As it consumes no fuel, the substitution of water for steam power would release to other uses all the extensive railroad and water facilities now engaged in transporting coal. It would similarly release a corresponding volume of labor now occupied in mining this coal and in operating such transportation agencies as well, and the boiler-room forces of the steam-power plants themselves."

Lava Fluctuations at Halemaumau

IN discussing the height of the lava in the crater of Kilauea, in the weekly bulletin of the Hawaiian Volcano Observatory, Director T. A. Jagger, Jr., says:

The January high level accords with a seasonal fluctuation which I have come to consider systematic and related to the sun's declination. There is tendency for lava to rise suddenly at solstics and to sink suddenly at equinox. This movement is complicated, however, by a secondary one, possibly due, at the two seasons respectively, to gradual restraint and gradual release of gas pressure, whereby there arises after the equinoctial fall a prolonged rising, followed by a shorter fall to solstice; while from after the solstitial rise there is apt to be a subsidence followed by a pronounced rise to the moment of the equinoctial fall. The amount of the effect of each crisis will be dependent on the equilibrium of the lava column itself with reference to its general trend upward, downward or stationary through a term of years, and it is complicated also by the relation of stiff magma underground to liquid lava. The latter is a foaming product of release of gas pressure in the stiffer substance, and consequently there arises special chemical heating. The solar effect can hardly be other than a squeezing of the rock crust of the globe causing rise or fall of the stiffer magma in the cracks, this being the mobile substance next under the rock crust. It will hence be seen that we have to do with

(1) Magma in general escaping through the ages of volcanoes, perhaps expelled by pressure downward of the crust of the earth;

(2) This magma squeezed in or under the cracked crust of the globe by the stresses induced in the equatorial protuberance of the sun's northing and southing in summer and winter;

(3) Expansion of this magma by gases in solution, when released under such changing stresses;

(4) Transformation of this magma by gases escaping from solution to bubble form, whereby gas reactions generate heat, liquidity and a foaming circulation to make what is called liquid lava.

These four motive powers, the first two terrestrial, the last two resident in the lava itself, cannot fail to complicate a curve representing the rise and fall of a lava column through the centuries, the years and the seasons. The net result for seven years past has been tendency to gradually rising lava in May and November, falling lava in June and December, sharp rising near June 20 and December 20; and a converse tendency to gradually falling lava in February and August, rising lava in March and September, sharp sinking near March 20 and September 20. It is this calendar which led the writer to watch with interest this year 1918 a falling off of the lava column after reaching the January 20-foot level; there was depression 40 to 50 feet below the rim from January 26 to February 8, with collapse and lowering of the crags to the middle of February and every evidence of subsidence.

Then came the pre-equinoctial rise and the evidence that it was to be extraordinary was the spurting up of liquid lava, beginning February 15, around the pit margins, in depressed areas, which have since filled quietly with large crescent-shaped outlying lakes. These are quite symmetrical, lying between the three great sector crag-masses and the outer wall, the sectors being lifted at the pit center, and the older lake occupies the three rifts between the sectors. This arrangement undoubtedly means a doming of the bench magma carapace, its rupture along three radial rifts and the welling up of the liquid lava through numerous shafts. The doming or intumescence of the hard floors of overflow has been the most remarkable feature of the last year, these being lifted into crags 90 feet high and more, and this hard substance has frequently risen faster than the lake so that the entire dish or saucer holding the lake has gone up bodily without any building by overflow. Recently this movement has been communicated to the outer wall of Halemaumau southwest, mashing up that margin by from 10 to 20 feet, as the swelling up of the central crags pinched the fresh fill of lava between them and the wall, and so displaced the wall.

A Method for Refrigerating Fish

A NOTE in a recent issue of the Consular Reports, of the Department of Commerce contains a description of the Ottesen refrigerating method, a Danish invention, as follows:

"Brine is poured into a sufficiently large insulated receptacle which contains a pipe in a spiral form or similar device connected with the circulation conduits of a refrigerating machine. The brine consists of water with perhaps 15 per cent of common salt. The spiral, by a continuous process, cools the brine until ice is formed on the spiral and the free surface of the brine.

"When the brine shows the proper proportions between saturation and temperature, which in case of necessity can be ascertained and controlled by an aerometer and thermometer, and when at the same time there is a suitable quantity of ice in the brine, the desired amount of fish to be refrigerated, well dampened, is put directly into the brine. They are kept in agitation by mechanical apparatus. Depending upon the size of the fish and the extent to which freezing is desired, the fish are kept submerged in the brine either a few minutes (for small fishes, baits, etc., and fishes to be frozen only upon the surface) or from 30 minutes to several hours (for cod, salmon, etc., which are to be frozen for long transportation).

"Because of the warmth stored in the fish treated, the temperature of the brine may gradually increase in the course of the process so that the ice on the spiral and on the surface of the brine will melt in part or entirely.

"As soon as the brine and the fish come in contact the wet surface of the fish will immediately be covered with ice without any osmotic action, so that the salt does not in any way get access to the skin of the fish, as in osmotic and chemical respects it is immediately insulated from the brine. Any penetration of the salt into the surface tissues of the fish, therefore, is out of the question, and will not take place even though the brine during the process, on account of an increased temperature, should not show the proper proportion between saturation and temperature.

"Upon being frozen throughout, or when the desired degree of refrigeration has been reached, the fish are taken out of the brine and rinsed. Then, as soon as they are exposed to the air, they are quickly covered with a layer of ice or hoarfrost, and in this condition may be stored or packed for transportation.

"When the brine in the receptacle has been cooled down to or below the temperature at which fresh-water ice is crystallized, a fresh amount of fish may be immersed in it. By suitable division of the receptacle, or by using several containers, the process may be carried on regularly in such a manner that fresh fish will continuously be put in at once place, to be taken up, cooled, or frozen at another.

"In many cases a refrigerating machine is not necessary, but the desired low temperature can be obtained by one of the usual methods of making up cooling mixtures."

Photos from The Gilliams Service

An immense heap of metal fragments, gleaned from the battlefields and gathered at a salvage station in France

The Junk Men of the War

What Becomes of the Wreckage of the Battlefield

A MODERN battlefield is a huge junk pile strewn with tons of wreckage of every sort which cost, when new, millions of dollars. Any one who could see such a field the day after a fight might well ask what becomes of all this costly wreckage. The answer is that modern efficiency methods have been introduced into the present war and that most of this battle metal is now salvaged by veteran soldiers known in the army as "ragpickers," who work under almost constant fire to reclaim the highly valuable wreckage of battle.

All kinds of old metal, iron, steel, copper, lead, bronze and nickle has more value today than ever before in the world's history, and a modern battlefield, one of these vast seas of interlapping shell holes, is the greatest junk pile in existence. As the prices of junk go nowadays it is a veritable gold mine to the army who can reclaim its wonderful treasures.

Standing in the midst of such a battlefield one sees French shells which were not fired because the artillery advanced when the enemy fled; German shells which failed to explode; mud-caked rifles, fallen from the hands of the dead or wounded or abandoned in flight, grenades left behind during the progress of the attack, damaged cannon and other bulky weapons, helmets, pieces of leather, pieces of clothing, debris of every description, lying pell-mell, haphazard, on the abandoned battlefield, lately all engaged, now silent as the dead, also to be seen here and there.

What becomes of all this highly valuable and huge mass of wreckage? As this war is largely being conducted by business men on business principles, most of it is saved. Every army now has a large force of laboring men, "official ragpickers" they have been called, who work fearlessly under fire in France, Flanders and Italy. In fact, on all the battle fronts to reclaim much of the wreckage, all really worth keeping.

The work requires intelligence and men who are experts in their line, as much of the debris they handle is highly dangerous because of the immense amount of explosives included, which for one reason or another have not spent themselves. So after all it is the real work of brave soldiers.

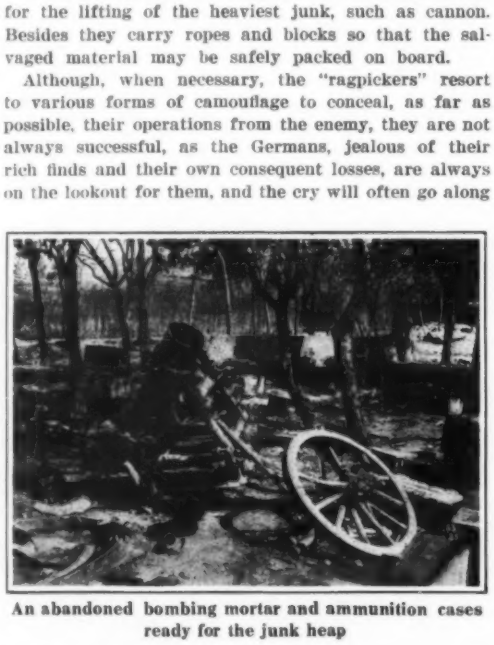
Another reason experts are required is that they must to a certain extent know exactly the material value of the various kinds of junk discovered, so that it can be properly sorted and classified and nothing that is valuable cast aside, while that which is worthless left to decay.

The battlefield "ragpickers" of the allied armies have been carefully formed into companies. The personnel of these organizations are mostly old soldiers, experienced, seasoned, unafraid; men who have seen much hard service, but who are for one reason or another more or less incapacitated for continued active service in the trenches.

At the break of day, immediately after a battle, these workers may be seen searching laboriously over the tortured earth, exploring it, as they go carefully along in every direction, for treasure trove. Every now and then they will stop when something of considerable value has been found and gathering in small groups they will combine their efforts in seeing that it is removed to the rear on the motor trucks and wagons which follow in their wake.

These conveyances are supplied with hoisting devices for the lifting of the heaviest junk, such as cannon. Besides they carry ropes and blocks so that the salvaged material may be safely packed on board.

Although, when necessary, the "ragpickers" resort to various forms of camouflage to conceal, as far as possible, their operations from the enemy, they are not always successful, as the Germans, jealous of their rich finds and their own consequent losses, are always on the lookout for them, and the cry will often go along



An abandoned bombing mortar and ammunition cases ready for the junk heap

their lines that the "ragpickers" are at work. It is then the business of the Hun sharpshooters to pick these men off whenever the opportunity for a good shot offers. So these "ragpickers," though their task may seem quite as humble as that of the old junk men in the city streets, are real heroes who constantly run great risk of their lives and are, as a matter of fact, not infrequently killed at their work. Yet those who are left, like good soldiers, are undisturbed by the loss of their companions and go ahead with their work no less tranquilly.

Everything possible that they find is utilized on the spot—such things, for instance, as small abandoned depots of cartridges or grenades. Everything dangerous, such as defective unexploded shells, is immediately destroyed for safety. The rest, and it is the vast amount of their findings, is sent to the rear on the trucks and wagons.

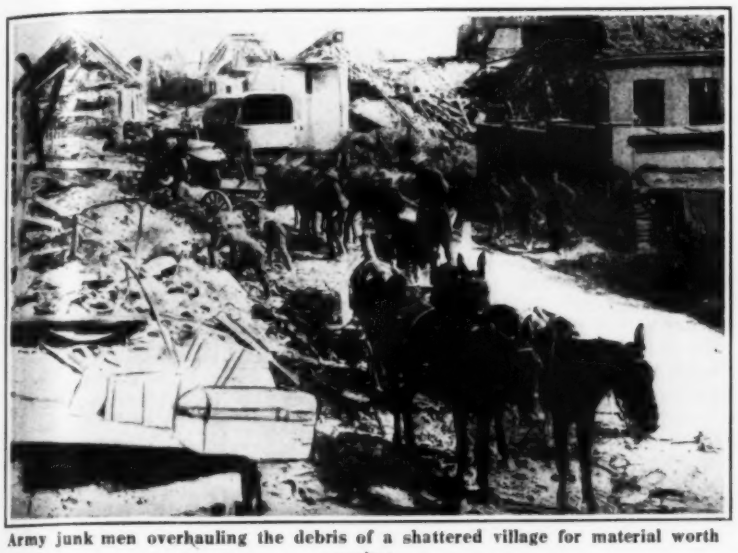
The work is naturally slow, as it can only be conducted in the uncertain light of early morning and when the evening shadows fall, and it may take a week to clean up a battlefield properly. Insofar as is possible a preliminary classification is effected on the spot, that is, if the enemy is not too active to prevent this, but it is in the rear, at the great sorting centers, that all this highly valuable debris for the salvage of which men risk their lives is cleaned and repaired and sent back to the front for further use.

Here are located hospitals for slightly wounded cannon, machine guns and rifles, where furnaces blaze night and day, and the vulcans work amid a thunderous crash and roar. Here are broken rifles to which a new lease of life is given and thus much money saved in the soldiers' most vital equipment.

The butts and wooden parts are repaired or renewed, the damaged metal parts are replaced by new ones, rusty barrels are freshened up, and so in a day or two these heaps of old iron, as they are brought in from the scene of conflict, are so many brand new rifles for all practical purposes, doing deadly execution in the trenches for perhaps many months to come.

When they have been safely transported back of the lines, the bigger guns, which it is impossible to repair outside of a well-equipped munition plant, are shipped to such places in the interior, back in the towns and cities not under fire, not to be returned to the front until weeks later, perhaps, when they are made over quite as good as new and ready to do fresh and deadly work on the ranks of the enemy.

No one who has not been on the battlefront in France and Flanders has the slightest conception of the vast amount of munitions and metal, only junk, when found by the "ragpickers," which has been economized in this way. If they had they might understand



Army junk men overhauling the debris of a shattered village for material worth saving

Photos by the Gilliams Service

A wrecked Austrian gun that can be rebuilt for future use by the Italians

its huge money and military value, and why the commanders of the armies are willing to risk the lives of their men in its salvage.

Perhaps a slight idea of its great value may be obtained from the fact that on the battlefields of one single army during a single month the following material was collected:

2,000 tons of iron and steel.
32 tons of copper.
1,000,000 rifle cartridges.
2,000 trench bombs.
1,048 rifles.

Last November, in a certain liberated region, the "ragpickers" of the army services "salvaged" the following quantities of material:

32 tons of red copper.
40 tons of bronze and nickle.
60 agricultural machines.
2,600 various tools.
800 yards of narrow-gauge railway.
Beams, telephone wire, leather and so forth.

What better proof could be demanded that the army ragpickers" do good, highly helpful and efficient work? These figures in themselves answer the question whether the cleaning up of a battlefield is justified.

To inspire the soldiers of the allies to further action and deeds of valor and also to make them fully acquainted with the arms of the enemy, the French army has been recently holding, just back of the front, a unique and most impressive exhibition of the German cannon salvaged from the battlefields.

French, American and English soldiers have been given every opportunity to make a careful study of the different types of small German artillery, and already it has been demonstrated to be of great help and benefit to them.

Scotland and the Scotch

"THE Scotch reached Scotland from Ireland and are not the descendants of Gaelic Celts who had been pushed north by a later (British) invasion of Britain. The first authentic information on Scotland dates from the time of the Romans, 79 A.D. Roman rule in Britain came to an end in 410, and Britain then ceased to be a part of the Roman Empire. The population of Scotland is made up of Pictish, Irish, British, Saxon, Danish and Norman elements, all of them Indo-Celtic, the three first, Celtic, the three last, Germanic peoples. The Picts contributed the bulk of the population, but were overcome by the Scotti (Irish), who had settled in Dalriada, a part of the present county of Argyle (Airer-Goidel, 'Margo Scottorum'). The Scotti then became the dominant people. Brythonic Celts dwelt in Strathclyde; their chief city was Dumbarton (Dun Brettan, 'Fort of the Britons'). Towards the close of the eighth century, the Danes appeared and ravaged the coast settlements and the isles. The Saxons first appeared in 428 in Britain. In the eleventh century Norman refugees first crossed the border into Scotland.

"The first Irish colonization in Scotland took place toward the end of the second century, but the kingdom of Dalriada was not effected until the close of the fifth. It is these Scotti who have given their name to Scotland. The relations between the two countries was very close and lasted for a thousand years, or at least up to the Reformation, and the early literature and civilization of Scotland belong to Ireland. The Scottish Gaelic reached its greatest extent in the eleventh century, when the Anglian-Celtic linguistic line ran from Tweed to Solway and to the Pentland Frith. The line has since been receding. Of the three parts into which Scotland is naturally divided, the larger part of the central and all of the northern, with the exception of the northeast part of Caithness, the Orkneys and the Shetlands, is Gaelic-speaking.

English soldiers inspecting trench helmets gathered at the front

The 1911 census showed 202,398 Gaelic speakers in Scotland, of whom 18,400 were monoglots.

"According to legend, the name Scotch is derived from Scota, a daughter of one of the Pharaohs. The word is probably related etymologically to the German Schatz, and means 'masters, owners.' Originally, and therefore in all medieval Latin texts down to the end of the eleventh century, it meant only Ireland. Since that date it means specifically Scotland. The Scotch Gael never calls himself Scotch, but Gael, or, to indicate his country, Albanach. English-speaking Highlanders, even though Scotchmen, are Saxons in the mind of a Gael. In the fifteenth century, when English became the predominant speech in the Lowlands, the English and non-Celtic Scotch called Gaelic 'Erse.' Since the sixteenth century the name Scotch has been applied to the English spoken in the Lowlands. So, by a strange freak of fortune, Scotch, originally applied to a variety of Celtic, has come to mean Broad Scotch or Quaint English, a language of Germanic origin.

"The distinction made between the Highlands and Lowlands of Scotland is correct merely so far as the physical configuration of the country is concerned, but incorrect if a racial significance is read into it. There is a mistaken notion that Scotland is a country of two races, Celtic in the north and Teutonic in the south, and that the latter element has displaced the former. No doubt the Lowland Scotchman is a person of very composite blood, but he is above all a Celt."—From a paper by Dr. Joseph Dunn before the Anthropological Society of Washington.

Conglomerate Russia

AT a recent meeting of the Anthropological Society of Washington Dr. Peter A. Speek delivered an address on the problems of race and nationality in Russia, in which he described Russia as a conglomerate of a large number of highly varied countries, races and nationalities united by conquests into one body politic, ruled up to the time of the revolution by the same monarch and the same laws and institutions.

In 1914 the population of Russia was nearly 180,000,000, the race composition of which was as follows: Indo-European, about 80 per cent.; Ural-Altaic, 14 per cent.; Semitic, 4 per cent.; indefinite, about 2 per cent. The statistics of nationality were as follows: Indo-European race—Great Russians, about 44 per cent.; Little Russians, 18 per cent.; Polish, 6 per cent.; White Russians, 5 per cent.; German, about 2 per cent.; Lithuanians, 1 per cent.; Lettonian, 1 per cent.; Armenian, 1 per cent.—Ural-Altaic race: Turkish-Tartar, 11 per cent.; Finnish, 2 per cent.; Esthonian, 1 per cent.—Semitic race: Jews, 4 per cent.—other minor nationalities of the above races, 2 per cent. of the whole population. The last Russian census shows that there were 123 different and distinct nationalities living in Russia. The Great Russians, about 44 per cent. of the population, ruled all the other subjugated nationalities, i.e., 56 per cent. of the whole population.

An Artificial High-Voltage Line

THE purpose of this article is to describe an artificial line constructed by the author for the Naples Electrotechnical Institute.

The line constructed by the author can stand a pressure of some thousands of volts and its characteristic constants can be easily changed. It is formed of three solenoids 36 cm. in diam., each consisting of 108 turns and 1.73 m. long; the wire is of German silver 3 mm. thick. Each solenoid has a resistance of 5.3 ohms and an inductance of 0.77 millihenrys. The capacity for each solenoid is constituted by 12 Moscicki condensers, one coating of each being connected to earth and the others to equally spaced points of the solenoid. The capacity of each condenser is about 0.002 mfd. The total capacity of the line can thus be as high as 0.076 mfd., its inductance 2.4 millihenrys, and its resistance 15.90 ohms. This artificial line is therefore equivalent to a real high-pressure cable some km. in length and of a natural wave-length of about 15 km.

Since for some practical cases the resistance is excessive, other solenoids are being constructed of brass wire, of double the number of turns and of about half the resistance of the former ones. The realization of other solenoids of copper wire and having a still larger number of turns is also being considered.

The author has employed the artificial line of German silver as a dummy antenna, which allows of measuring instruments (ammeters and spark-gaps) being easily inserted at different points in order to study the conditions of production of stationary waves of the fundamental and higher frequencies. He finally discusses the possibility of employing his artificial lines for studying and comparing the different protective devices for electric lines.—Note in *Science Abstracts* on an article by L. LOMBARDI in *Electrotechnica*.

Present Day Problems of Plant Geography—II*

As Related to the Necessity for Intensified Production

By Jean Dufrenoy, Assistant at the Arachon Biological Laboratories

[Concluded from Scientific American Supplement No. 2207, April 20, 1918]

II. GENETIC AND MORPHOGENY

§ 1.—FLUCTUATING VARIATIONS AND PROFOUND VARIATIONS

All living creatures vary under the influence of ecologic factors. "A new creature is not merely one more proof from a plate stereotyped once for all" (Baudement). Variations always affect not only the different plants of the same group, but the different parts of the same individual.[41]

Most often these variations are of slight amplitude: all the intermediates[42] are found between their extremes; the name of *fluctuations*, or *oscillating variations*, given to them, therefore, shows that it is necessary to regard them as oscillations of morphologic or physiologic equilibrium around a middle position.

The profound variations which cause an individual very different from its near relations to appear in a species are distinguished by their greater amplitude and by certain features lacking in the intermediates.

§ 2.—THE CAUSE OF VARIATIONS

To what modifying agents can variations be attributed? In the first place to *crossings* between different types (vicinism), and some biologists consider this to be the sole possible cause of the so-called abrupt variations or mutations. In the next place to *living and non-living factors of the environment*. A given environment, a given flora.

For a similar area the more varied the physiography of the region the more varied the flora.[43]

In any flora *the proportion of the genera to the species* (Jaccard's generic coefficient) *is inversely proportional to the diversity of the ecologic conditions;* in uniform country (the dunes of Morocco) there is only one species to each genus; in very broken country (Switzerland) each genus contains three or four, or a large number of species, according to the habitat.

The diversity of organisms is simply the result of the modeling by ecologic conditions of a small number of fundamental forms.

The fact is that "there is no more sensitive reagent than living matter; it is flexible enough to adapt itself to all the variations of the exterior and the interior milieu."[44] A given milieu, a given plant.

The facts of adaptation to soils and to parasites are well known: it was in America, the land of the phylloxera, that there were found the vine-stocks resistant to the insect; it is in the Roman campagna, a humid country, that we find the wheats resistant to cryptograms (Rieti wheats).

Superalimentation exaggerates the development of the vegetative organs, enabling the horticulturist to obtain double flowers by the sterilization of the stamens. It provokes tuberization and transforms the wild carrot into the cultivated carrot, the wild beet (*Beta maritima*) into the sugar beet,[45] the night shade (*Solanum Commersonii* and *S. Maglia*) into the edible potato of heavy yield.[46]

Lack of food, on the other hand, hunger, prevents the tuberization of radishes.[47] Thirst diminishes the production of vegetative organs and makes the flowers appear prematurely on soils which are sloping, sandy or dried by the wind. This is shown by observation of the cycle of evolution of the *Cakile maritima*, at different points of the Arcachon Basin.[48]

In the inflorescena of the maritime pine of the littoral the action of the maritime wind causes the staminal leaves of the periphery of the male flowers to develop into sterile parts, into a protective perianth. Between these sterilized scales the floral branch elongates its internodes, assuming the aspect of a growing branch, or rather, suddenly arrested in its development, it remains rudimentary, and takes the characters of the female flower.[49] Inversely the cone bearing branches cease to produce anything but male flowers when they are shaded by the new branches or enfeebled by any other external cause.[50]

A change in the milieu often affects the sexuality:[51] of the 200 species of plants which MacDougal[52] had transported to the tops of mountains, the seashore, or into the desert, a score survived; but sexual reproduction was always greatly diminished and vegetative propagation played a more important part.[53] Dr. Larcher has shown that *tumors* cause abrupt variations to appear in the shoots which he caused to spring in large numbers on the stems[54] (galls, excrescences, "witches brooms," etc.).

Finally, according to Blaringhem,[55] "it is in *mutilations* that we must seek the possibility of obtaining new forms." Grafts are mutilations, and *the pretended hybrids through grafts are doubtless variations of traumatic origin.* Mutilations also of a single plant, which naturally cannot furnish graft hybrids, probably cause morphologic and even physiologic variations; they may increase precocity and productivity, transform late maize into early maize (Blaringhem),[56] or advance the maturing of tomatoes by a month.[57] The amputation of large branches (rejuvenation "dehorning") transforms sterile old trees no longer bearing either leaves or fruit into productive trees.[58]

Practical horticulture also makes use of *annular incision* as well as *grafting* to increase the fecundity of plants. By annular incision of the root J. Brzezinski[59] provoked in the Raifort (normally sterile) the formation of perfectly formed seeds; the fecundated ovules, better nourished, soon became larger and their embryos developed.

§ 3.—VARIATIONS IN AGRICULTURE

The variation does not affect the entire plant; it affects a given member of character and causes polymorphism of the vegetative organs by an "infinitely varied modeling of a few fundamental forms."[60]

Variations of form displays itself immediately, first striking the eye, and we wrongly attribute to it a value of its own, whereas it is merely the result and the indication of a variation of function or of composition. Morphologic variations are of interest only to the horticulturist.

Physiologic variations are important to the agriculturist, who must prevent their return if they are prejudicial, and fix them if they are profitable. Diminution of yield, of vigor, of resistance to disease, enfeebling of special desired aptitude, are all consequences of secondary importance for food or fodder plants, but qualities which greatly depreciate the value of industrial plants because of the lack of uniformity in the crop.[61] Inversely, variations may exaggerate desirable qualities (hardiness, productivity, etc.) and suppress unfavorable characters (thornless cactus and furze).

§ 4.—ECOLOGIC FACTORS OF SEXUALITY

Varions in sexuality are those most alluring to the biologist. Dr. O. Larcher calls attention[62] to the fact that in plants as well as in animals, mutilations, or even mere troubles of nutrition, are sufficient to produce male characters in female specimens.

In a member which ought to be fertile ecologic factors may cause the function of reproduction to be replaced by the function of nutrition, of multiplication, or of protection.[63]

A young shoot of the pine will bear, according to the conditions of the locality, fertile branches (flowers ♂ or ♀), adventitious branches (protectors of lateral stalks), or assimilators (with green needles).

"The causes of sexuality are determined as a function of the physiologic state of the organism and of the composition of the milieu.[64]

Sexuality appears to be in its very essence a response to the operation of ecologic factors. When a cycle of vegetative activity is closed by arrival at a state of senility it cannot be repeated except as the consequence of some process of rejuvenation. Conjugation and the production of seed prepare, or form a part of, the most common process.[65] But there are others.

When a bud develops immediately without a period of rest it presents no sign of rejuvenation; it continues the cycle until senility is arrived at, taking for its point of departure the age of the axis at its point of insertion. But the bud which does not develop immediately can not resume its vegetative activity without a phase of rejuvenation.

When the seed germinates the stem of the plantlet bears, above the cotyledons, primordial leaves which have not the same form as adult leaves.

When the buds of perennial plants open in the spring after the winter rest, the young stem which they develop still bears primordial leaves, before forming adult leaves.[66] When traumatisms or the mortification of terminal shoots causes adventitious or lateral dormant buds[67] to develop, the stem which they produce first bears primordial leaves.[68]

The example of the *Ulothrix* shows that between a sexual rejuvenation and sexual rejuvenation all the intermediates are to be found: the adult filaments of this little fresh water Alga produce at the beginning of winter agametes, which all develop directly into adult algæ, and later they produce gametes capable of developing indifferently after conjugation or without conjugation. Finally, in the spring ecologic conditions are such that all the gametes are obliged to be conjugated in order to develop, and not to perish.[69]

Though conjugation is not the sole mode of rejuvenation, does it remain, as is believed by Maupas,[70]

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*Translated for the Scientific American Supplement from Revue generale des Sciences.

[41] Schribaux: General Agriculture.

[42] Mallèvre: Zootechnology (course offered at Agronomic Institute).

[43] J. W. Harshberger: The Diversity of Ecologic Conditions and its Influence on the Richness of Floras. *Proceed. Acad. Nat. Sc. Phila.*, p. 419-425, Aug. 1915.

[44] J. R. Carracido: The Foundations of Biochemistry. *Scientia*, I-II, p. 137, 1917.

[45] Heiot, Proskowetz, Schindler, J. Dufrenoy.

[46] Labergerie, Heckel.

[47] Mlle. Trouard-Riolle: Experimental Researches on Radishes * * * *Ann. Sc. Agronom. Fr. et étrang.*, 1914.

[48] These seeds germinate in the spring; 25% of the embryos are *monocotyledons.*

[49] J. Dufrenoy: Remarks on the Occasion of the Modifications Produced by the Marine Wind on the Male Inflorescence of the Maritime Pine. *C. R. Soc. Biolog.*, p. 174, Feb. 17, '17.

[50] Th. Mechan: The Law Governing Sex. *Proceed Ac. Nat. Sc. Phila.*, 1878, p. 26, and Giard: Variations of Sexuality in Plants. *Oeuvres Diverse*, vol. 1, p. 577, Paris, 1911.

[51] Dr. O. Larcher: *loc. cit.*

[52] Modification of Germ Plasm. *Ann Mo. Bot. Garden*, vol. II, p. 252, 1915.

[53] The *Elcodea Canadensis* reproduces itself by the sexual method in America, but asexually in Europe where the flower ♀ has not been observed. (Dr. Lalesque: *loc. cit.*)

[54] O. Larcher: Contribution to History of Tumors of the Stem * * * *Report 1st Internat. Congress of Comparative Pathology*, Paris, Oct., 1912.

[55] "Abrupt Transformation of Living Creatures," Paris, 1911.

[56] This variety, a soi-disant new one, has, according to Griffon, no practical value and is not stable.

[57] Bassi; Munro (at Rosthern) makes a résumé of his observations in the following table:

Tomatoes Pruned—First Ripe Fruits—Varieties: Alacrity, Rennies, Sep. 2; Earliest Round, Aug. 10.

Tomatoes not Pruned—First Ripe Fruits—Varieties: Alacrity, Rennies, Sep. 10; Earliest Round, Sep. 10.

Report Experimental Farms, Ottawa, 1916.

[58] M. B. Davis: The Restoration of the Neglected Orchard, Ottawa, 1914, and E. Fau: Rejuvenation of Fruit Trees and Production of Fruit, *Vie Agric*, p. 17, 1916.

[59] *Bull Acad. of Sc. of Cracow*, 1909.

[60] Péchoutre: Review of Botany. *Rev. Gen. d Sc.*, Aug., 1915.

[61] J. R. Carracido: *loc. cit.*

[62] V. Cayla: Spontaneous Variation in Plants. *Vie Agric.*, vol. IX, p. 313; 1916. In the Vosges the distilleries and starch factories require, in order to prosper, that the cultivation of pure and fixed breeds shall give them potatoes with an invariable percentage of nitrogenous matter and of starch. (*Ann. Sc. Agron. Fr. et. Etrang*, 1914).

The rubber industries suffer greatly from the non-uniformity of the latex. (The Present State of the Synthesis of Rubber. *Rev. Gén. d. Sc.*, p. 151 (in a note), Mar. 15, 1917.

[63] Dr. O. Larcher: Contribution to the History of Female Birds in which the External Attributes of the Male Sex Have Developed. *Bull. Soc. Centr. Médécini Vétés*, July 22, 1916. *Vide* the bibliography in a separate publication.

[64] J. Dufrenoy: *loc. cit.*

[65] Fauré-Frémiet: Protistology. *Rev. Gén d. Sc.*, p. 315, 1908.

[66] Alex Braun (1851); G. H. Shull: Stages in the Development of *Sium cicutaefolium*. Carnegie Inst. Washington, 1905.

[67] Jackson, 1899; Cushman, 1904; Shull, 1905; J. Dufrenoy, 1917.

[68] Wounds, insect stings, can make any cells whatever of the bark develop into *adventitious buds.* The pith of the branches formed does not communicate with that of the stem. (G. Bonnier and Leclerc du Sablon: Botony, vol. 1, p. 239, 1905). Perhaps buds which are adventitious and dormant behave differently in the case of rejuvenation.

[69] Dr. O. Larcher: *loc. cit.*; T. Deveaux; P. V. *Soc. Lin. Bordeaux*; J. Dufrenoy: *loc. cit.*

Whether we admit Von Baer's view (1828) that "ancestors and descendants pass through the same larval phases," or that of L. Agassiz (1848) and Heckel (1868) (1866) that "the adult characters of ancestors appear in the descendants as larval (or juvenile) characters," we are forced to regard the primordial leaves as larval organs, a reminder of the leaves possessed by the ancestors of the plant.

[70] Cr. Janet: Sporophyto gametophytic Alternation of Generation in the Algae, p. 66, 1914.

Bütschli, Hertwig, and others, the sole remedy against senile degeneracy and natural death?[71]

After Enriques, Brown (for the Spirogyræ),[72] Woodruff and S. Metalvikoff[73] (for the Infusoræ) have shown that the lower organisms can produce themselves indefinitely without conjugation and that, in *a favorable location*, they are immortal.

It is, perhaps, only unfavorable conditions, and the approach of death, which cause sexual reproduction to make its appearance.[74]

Fecundation, moreover, is nothing but a chemical effect resulting from the action of oxygen, or of certain ions,[75] on the substances in the ovule to make them soluble. Sexual rejuvenation is a very different phenomenon.[76]

It is, above all, *the period of repose*, the *cyst or spore phase* of the Thallophytes, the *macrospore phase*[77] of the vascular Cryptogams, the *seed phase* of the Phanerogams, the *winter repose*[78] of perennial plants of temperate countries, the *repose* of the Mesophytes of the desert during the dry season,[79]—it is *latent life* which characterizes rejuvenation in general.[80]

The passage from latent life to active life cannot take place without excitation. F. W. Covelle has just shown this for the buds of whortleberry Myrtille (*Vaccinium*), which, when it is not exposed to the frosts of winter, does not transform its amylaceous reserves into sugar, and does not develop in the spring.[81]

Heat and humidity suffice to release the development of the majority of seeds or winter buds.[82]

However, the seeds of the *Orchidaceæ*[83] and of the *Ericaceæ*[84-85] (heather, arbute berry[86]) in order to germinate must be excited by symbiotic fungi, and the same phenomenon is perhaps very general (hard seeds).

§ 5.—ORIGIN OF VARIETIES

The action of the ecologic milieu constantly modifies vegetable types. It is within man's power to direct these variations in a favorable direction or to provoke them experimentally. It suffices to disturb the plant, by intervening in the phenomena of reproduction (crossings, castration, etc.), by operating upon the conditions (change of climate, troubles of nutrition, overfeeding, hunger, etc.), by mutilating the plant (traumatisms, grafts, etc.), or finally by the action of various agents (radium, toxins, etc.).

By these means we are enabled: (1) To provoke the development of dormant or rudimentary buds; (2) to modify the composition of the germinative protoplasm of the sexual cells, or of young tissues in the process of growth, and thus to alter the course of their development and their heredity.[87]

Rejuvenation and adaptation explain in general the polymorphism of plant organs and organisms.[88]

Most often the action of ecologic factors, of parasites, traumatisms, grafts, creates nothing new: by interfering with nutrition it imposes upon organisms periods of latent life and of rejuvenation. The rejuvenation may be accomplished sexually (conjugation) or asexually. The larval characters which it causes to reappear in more or less amplitude have been described as variations. However, in response to the stimuli of the exterior conditions, races which are really new should appear slowly, or perhaps abruptly, by adaptation.

III. GENERAL CONCLUSION

After having been directed successively towards morphology, embyology, histology, the attention of biologists is concentrated on the relations of organisms with the external environment,[89] with the object of determining what forces cause living creatures to vary, what is the extent of variation,[90] and what advantage may be derived therefrom.

These studies acquire great practical importance at a time when it is vital to extract from the soil all it is able to supply, and to re-establish natural harmony over vast areas ruined by the war.

The countries which obtain the richest harvest from their soil are those which have best known how to instruct their rural populations.[91] The example of the Turkish Empire and of the Mediterranean countries shows that, as Chateaubriand said, in the countries where the laws of phytogeography are not respected, "the forests precede man and the deserts follow him."

In the bitter economic struggle, which is to be foreseen after the war, our products must compete with those of our European rivals and against those of the same kind or against cheap and abundant substitutes from overseas.[92]

In order to succeed we must rigorously adapt crops to conditions, strongly accentuate specialization, cease to impose upon soils crops decided upon *à priori*. Nature will resume her rights, and the examination of natural conditions will become the basis of a rational exploitation of the land, such conditions dictating the choice of plants and the proper method of raising them.[93]

And production will no longer be everything. The farmer should no longer sell the raw products of his land directly. An essential condition of prosperity, for the country in general as well as for the farmer in particular, is to export, not what the earth produces, but what man creates.

The exploitation of natural plant wealth, the cultivation in each locality of the plant best adapted to it, the re-establishment between arable areas and forest areas of that equilibrium which agricultural prosperity exacts, the restoration of the destroyed vegetation in our devastated regions—these are alike questions of botanical geography. Upon their solution depends the growth of the population, the prosperity, and even the very existence of the country.

[71] E. Maupas: Not. nécrolog. *Rev. Gén. d. Sc.*, p. 669, Dec. 15, 1916.

[72] Calkins (1902): By adding to his cultures extracts of the thyroid gland, retarded without avoiding the senility of the Infusoria.

[73] Algal Periodicity (*Bull. Toir. Bot. Club*, vol. XXXVIII, 1908), cited by H. Danforth: Period in Spirogyra (*Bot. Mo. Gard.*, p. 51, 1910).

[74] Immortality of the Protozoa (*E. R. Réun. Biol. de Petrograd*, p. 241, Nov. 29, 1916)—Metainikoff employs a solution of Liebig's extract of meat (0.25 per cent) and changes it every day, thus eliminating, as did Enriques, autointoxication due to the products of exchange and secretion; these cultures lived 7 years without conjugation.

[75] MacDougal: Water Balance of Desert Plants. *Ann. Bot.*, 1912.

[76] J. R. Carracido: *loc. cit.*

[77] Normally the ovule is excited by the spermatozoon, but Loeb has shown that the sexual excitant can be replaced by mechanical, physical, or chemical excitants. Loeb: Chemical Fecundation. (translated by Anna Drzewina) p. 35, *Mercure de France*, Paris, 1911.

[78] Bonnier and Leclerc du Sablon: *loc. cit.*, p. 1434.

[79] The winter rest of the vine diminishes in duration as one goes toward the South, but in the forcing houses it is deemed necessary to provoke an artificial rest of 4 months to obtain regular production and ensure the duration of the vine. (Pacottet: *loc. cit.*, p. 72.)

[80] MacDougal: Infl. of Aridity in the Evolutionary Development of Plants. (*The Plant World*, Oct., 1909).

[81] The accumulation in cysts, spores, seeds, and buds of nutritive reserve substances assimilable by the rejuvenated organism appears to be a general necessary fact. (J. Dufrenoy: *C. R. Soc. de Biol.*, p. 9, Jan. 6, 1917).

[82] If of two branches of the same plant, one passes the winter in a greenhouse, while the other, extending through an opening of one of the window-panes, is exposed to the cold weather conditions of the atmosphere, only the buds of the second will develop in the spring; those of the first will remain eternally dormant. (F. W. Coville: The Wild Blueberry Tamed. *Nat. Geog. Mag.*, June, 1916; after researches by the U. S. Dept. of Agric.).

[83] MacDougal: Environic Factors. (*Pop. Sc. Monthly*, May, 1914) has shown that conformity to the law of Van't Hoff, the speed of transformation of reserves, and consequently the speed of development, are doubled by a rise of temperature of 10° (presumably centigrade).

[84] Noel Bernard: Studies on Tuberization. *Rev. Gén. des Sc.*, p. 8, 1902.

[85] Chevely Rayner has proved (Recent work on Endotropic Micorhiza: The New Phytologist, vol. XV, p. 167, Oct., 1916) that when *sterilized* the seeds of *Calluna Vulgaris* yield in *an aseptic medium*, plantlets incapable of forming roots or acquiring leaves. Inoculation with the symbiotic fungus (Phoma) causes them to form roots and develop into normal plants.

[86] The infection of the *Myrtille* or of the arbutus (Dufrenoy, unpublished) has been confirmed; but its necessity has not been demonstrated.

[87] MacDougal: *loc. cit.*

[88] The growth is only a particular case of sexual rejuvenation.

[89] Old Fashioned Natural History. *Bull. of the Scripps Inst. of the Univ. of California*, No. 1, Dec. 30, 1916.

[90] D. T. MacDougal: Biological Research Institutions. *Ibid.*, p. 7.

[91] *Rev. Gén. des Sc.*, Dec. 30, 1916, p. 704, and H. Sagnier: *L'Union Française*, No. 1, Feb. 1917.

[92] According to E. Coquidé exotic countries yield not only products of *complement*, but those of substitution (fibers, oils, oil-cake, etc.). (The Biologic Method in the Study of the Properties of the Soil; *Vie Agric.*, p. 41, No. 29, 1916).

[93] Id: *Ibid.*

The Relation Between Chemical Constitution and Physiological Action*

THE relation between chemical constitution and physiological action occupies a definite and important place in the study of drugs. Chemical investigation of a drug begins with the attempt to isolate the principle to which its activity is due. Then follow the determination of its constitution and the synthesis of a number of substances related to the parent compound, and comparison of their physiological action.

The wideness of the term "physiological action," covering as it does any action on the living organism, renders its discussion difficult. It is impossible, for instance, to compare the bactericidal action of phenol with the hypnotic effect of diethylbarbituric acid, or with the anesthetic action of cocaine, for the same superficial signs of physiological action may be due to widely different causes. Examples of physiological action are not wanting. Compounds of similar constitution generally possess a characteristic group-smell, whilst each member may have a specific odor. Sense of taste also provides an occasional means of discrimination not only between side-chains of different length, but also in certain cases between stereoisomerides.

Stereochemical influences often exercise profound effects, particularly on nerve-endings. Thus *l*-hyoscyamine has about a hundred times the mydriatic action of *d*-hyoscyamine, and *l*-adrenine many times the pressor effect of the dextro-compound. Asymmetry of a nitrogen atom may also condition a difference, as in the case of the *α*- and *β*-methochlorides of *l*-canadine. The cause of this variation still remains in doubt.

The influence of physical properties, such as solubility in different media, may be of importance, and it has been shown that for a particular series of aliphatic compounds their narcotic effect on tadpoles was proportional to the partition-coefficients of their solubilities in oil and water.

As an indication of the effect of chemical properties, it has been shown that whilst certain basic dyes stain the grey nerve substance, their sulphonic acids do not. This difference suggested that bases, liberated in the blood-stream by alkalis, are extracted by the nerve substance, whilst their sulphonic acids remain in solution as alkali salts.

In the case of alkaloids it is a general rule that the introduction of a free carboxyl group profoundly modifies the physiological action. Benzoyl ecgonine, of which cocaine is the methyl ester, has no local anesthetic action; whilst quitenine, obtained from quinine by oxidation of the vinyl group, is non-toxic. Formation of quaternary salts has also a considerable effect. For instance, papaverine has a strychnine-like action which is missing in its methochloride, and reappears in its reduction product laudanosine.

In the many cases in which members of a group of compounds of similar constitution resemble one another in physiological action it is of interest to observe the effect of slight chemical alterations. The following four pieces of work were then outlined: (1) *Tropeines* (acyl derivatives of the amino-alcohol tropine); (2) *aminoalkyl esters* (formed by the esterification of an *acid* with an *alcohol* containing an *amino*-group); (3) *adrenine and the amines* (adrenine is the active principle of the suprarenal gland); (4) *protozoacidal drugs*. The results of experiments that have been made on the relative toxicity to infusoria of a number of cinchona derivatives, with a view to their employment in the treatment in malaria, indicate that ethylhydrocupreine was the most active, but they do not admit of any certain conclusions as to the relation between their chemical constitution and protozoacidal action.

Experiments have also been made on the relative toxicity of the ipecacuanha alkaloids to amœbæ, and they indicate that the full amœbacidal action characteristic of emetine is exhibited only when the nucleus is intact.

*Summary of a lecture before the Chemical Society, by Dr. F. L. Pyman.—Reported in *Nature*.

Contraction of Volume of Certain Substances When Dissolved in Water

FROM the specific gravities of certain substances, that of water at different temperatures, and those of the solutions of these substances in water, Mr. J. N. Rakshit has calculated the contraction of volume resulting when a fixed quantity of each substance is dissolved in increasing quantities of water. The results are tabulated in the Proceedings of the Indian Association for the Cultivation of Science (vol. 111., part iv.), the substances dealt with being hydrochloric, sulphuric, nitric, formic, acetic, and tartaric acids; stannic and sodium chlorides; ammonia, sodium, and potassium hydroxides; methyl, ethyl, propyl, *iso*-butyl and *iso*amyl alcohols, glycerol, phenol, dextrose, lævulose, maltose, invert- and canesugars, acetone, chloral hydrate, acetonitrile, and nicotine. Study of the figures obtained shows that in some cases the contraction of volume increases with the increase in dilution, but in several others as the dilution increases a point of maximal contraction is observed. The maximum contractions are constants, and different for different substances. In the cases of sodium chloride and of acetic and sulphuric acids the contraction of volume at all dilutions diminishes as the temperature rises. It is not yet known whether this phenomenon is due to differences in the coefficients of expansion of water and of the solute.—*Nature*.

Observations on Dropping

And on the Measurement of the Superficial Tension of Liquids by Means of Drops*

By F. Louis Perrot, Doctor of Science, Geneva

WHEN, in the open air and under sufficient pressure, a liquid flows through a capillary tube of a size comparable to that of the spouts of pipettes or of ordinary medicine droppers, the flow is at first in the form of a liquid stream. It goes without saying that the speed of the flow will diminish slowly in proportion to the lowering of the level of the liquid in the reservoir. But in order to observe the process of the flow it is far more practical to restrict the speed of flow more rapidly, and even to control it at will by means of some device enabling one to interrupt or suppress the entrance of air into the top of the reservoir.

As the issue of the liquid from the orifice of the capillary grows slower and slower, we observe that with liquids of low or medium viscosity the stream begins to lose its apparent solidity, then wavers, while the globules of the liquid, at first massed under the orifice, descend at regular intervals along the stream, which quivers in the way a whip does. The globules seem to slide on the stream like large beads on a string. If the discharge is retarded still more the beads succeed each other rapidly and the thread is broken everywhere.

Dropping, properly so called, begins, and we are soon able to count the true drops at the rate of so many per second. We may attempt to collect and weigh a definite number, or to estimate their size by dividing by their number the volume by which the contents of the reservoir have diminished between the first and last drops of the number counted.

Dropping in general has been made the subject of research for quite a long time. Frankenheim was probably the first to observe that the volume of the drop diminishes with the speed of flow. This speed is characterized by the duration of the formation of a drop, or by the interval of time which elapses between the fall of two successive drops. G. Hagen and F. Guthrie also proved that the greater the speed the heavier the weight of the drop. C. Forch, having also remarked the influence of the speed, brought his observations, by means of calculation, to a speed characterized by a 5 seconds interval between two falls, in order to be able to compare the weights of drops of various aqueous solutions.

H. Siedentopf has also noted the effects of the speed on the weight of the drops; Ph. Lénard also furnished data along the same line. But it was G. Rosset who first proved that the weight of the drops is not a linear function of the speed, and that this weight passes through a maximum when the speed increases regularly. We have ourselves made a similar observation, somewhat later and have insisted on the importance of the duration of formation.

Recently three notes of E. Vaillant and one of L. Abonnene have had for their goal an attempt to formulate the laws of the variation of weight with speed, taking into account the several maxima observed in the course of their experiments, in place of the single maximum noted by Rosset. Dynamic actions of the flow are evidently the cause of these variations of weight: the liquid issuing from the tube resolves itself into drops whose volume will vary according to the speed it possesses at the moment of its fragmentation; this volume will change with the form taken by the drop before it detaches itself. "Tails" and "nipples" will be produced above and below the more or less ovoid mass which constitutes the principal part of the drop. (These protuberances may be seen above the numbers 11, 12, 16, and 17 of fig. 1, which is taken from one of our mémoirs, which gives a very detailed description of the dropping of water and of benzine.

If, therefore, we wish to compare drops of different liquids, it will be necessary not only to make them issue from tubes of like dimensions, but also to give them durations of formation as nearly equal as possible. The simplest means consists in rendering practically nil the effect of the dynamic disturbances of the flow, by giving a very slow duration to the drops, i. e., by insuring very long intervals between the fall of two successive drops. We note then that the weight of the drops remains indefinitely constant, other things being equal. We have given the name *static drops* to these very slowly formed drops, and have found that in order to make sure of the disappearance of any dynamic effect of the flow it is requisite that the interval of fall should be at least 45 seconds.

In Guthrie's memoir there is to be found an attempt at measuring the centesimal composition of certain mixtures of liquids by comparing the weight of their drops by means of an apparatus which he calls a *stalagmometer*. But it was Tate who, in 1864, believed he had found a very simple relation between the weight of a drop (static) of a liquid and its capillary constant. But since the means of measuring this constant, or the superficial constant upon which it depends, are not many, and a knowledge of them is rather important, especially in Physical Chemistry, many authors have attempted to have recourse to the principles stated by Tate as if true physical laws were here concerned.

It is necessary to quote the classic text of Tate's announcement in the *Philosophical Magazine*, (vol. xxvii, p. 176; 1864):

1. Other things being equal, the weight of a liquid drop is proportional to the diameter of the tube in which it is formed.

2. The weight of the drop which flows from a tube is proportional to the weight of the liquid which would be drawn upward in that tube by capillary action.

3. The augmentation of the weight of the drop is proportional to the diameters of the circular surfaces upon which it is formed.

4. Other things being equal, the weight of the drop is diminished by an increase in the temperature.

We observe in these four principles, and others which accompany them, accessory points which had already been the subject of observations previous to those of Tate, e. g., the effect of the temperature. Hence there is no need of spending more time on this point. We will confine ourselves to retaining principle 2, and principle 1 in so far as it is connected with 2 in its application to the measuring of tensions by means of the weights of drops.

A general *résumé* of the laws of Tate has been expressed in the following equation: $P=2\pi r\gamma$, which establishes that the weight of the drop is equal to the superficial tension multiplied by the circumference of the tube of flow.

This formula implies that: 1, for the same liquid (γ being constant) the weights (P) will be proportional to the sections of different tubes; and 2, for the same tube (r being constant) the weights will be proportional to the superficial tensions of the various liquids.

But all the authors who have attacked the application of these laws have found that things do not occur as simply as might be expected. Ph. A. Goye and myself have devoted two studies to this question.[1] In the first will be found the analysis of all the works upon this subject which have appeared up to 1900. Following this analysis we gave the results of our own attempts to apply Tate's laws to the measuring of superficial tensions. We made four series of experiments therein, varying the experimental conditions from one to the other. None of them led to an entirely satisfactory result, i. e., one giving *precisely* and *immediately* values of superficial tensions equal to those found by other methods, notably by that of capillary ascensions. One of the four series,—the second,—however, enabled us to obtain approximate results, but by making use of an empirical formula of correction.

In a second memoir, preceded by several preliminary notes, we undertook the study of the dropping of liquids in a more general fashion, and described the variations of form and of weight of drops of more or less rapid formation and of those of very slow formation (*dynamic drops* and *static drops*). Cinematographic films enabled us to catch the variations of form during the detachment of the drop and to discuss certain hypotheses encountered in the course of the abstracting of previous or contemporary works.

Since the period of our researches a large number of notes and memoirs relating to the subject have appeared. Without making new investigations we have taken note of those of others, and it has recently seemed worth while to us to collate and analyze all these in a memoir which the author of the present article has just published in the *Journal de Chimie Physique* (vol. xv, p. 164; 1917).

We refer to this for the analysis of the works in question and for their bibliography of more than 50

Fig. 1.—Diagrammatic figures relating to dynamic drops

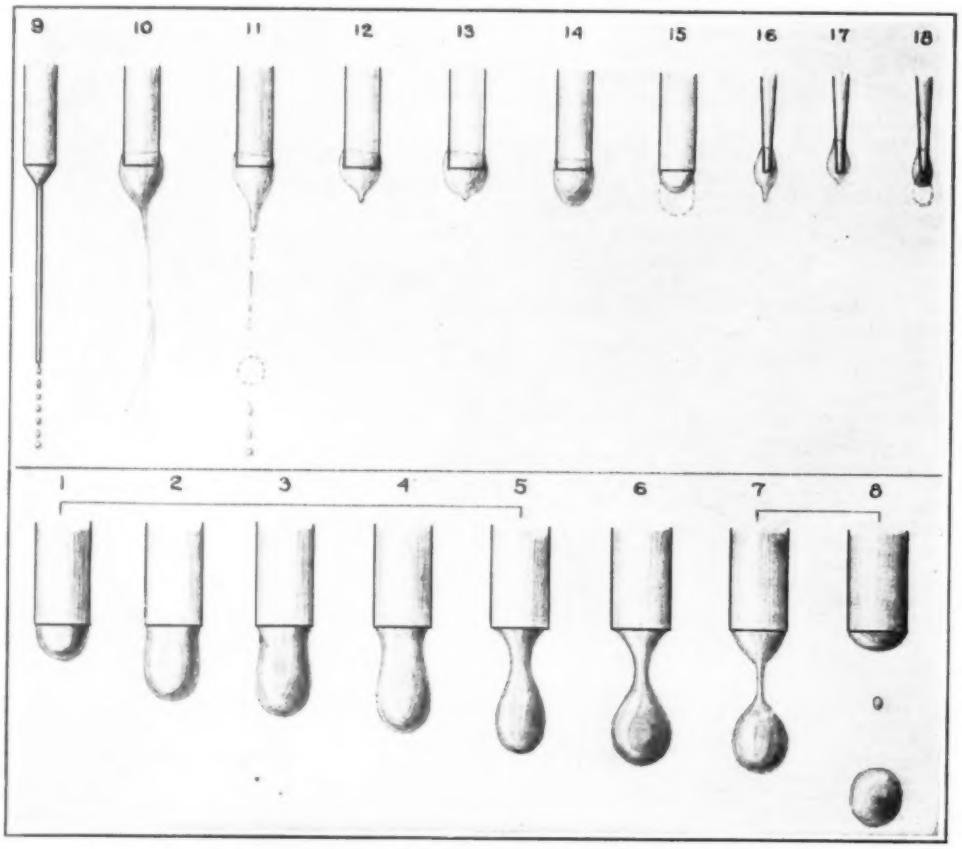

Fig. 2.—Cinematographic profiles of the phase of detachment of a static drop
These figures synthetize the forms observed either directly or upon the cinematographic film

*Revue Générale des Sciences (Paris).

[1] Ph. A. Guye and F. Louis Perrot: Critical Study of the Employment of Droppers in the Measurement of Superficial Tensions. *Archives des sc. phys. et nat.*, vol. XI, pp. 225 and 345 (1901); and Experimental Study of the Form and Weights of Dynamic and Static Drops, *Ibid*, vol. XV, p. 132 (1903).

titles, dating from 1900, thus avoiding the overweighting of these columns with references.

Works relating to the application of the so-called Tate's laws have varied according to the scientific orientation of their authors. The adepts of Mathematical Physics have treated the relation between the weights of drops and the capillary constant as a problem of analysis, starting from the fundamental formulas of the capillary theory. They have sought to establish the equation of the profile of the mass of a liquid suspended under a circular plane surface (representing the section of the tube of flow), and to discover by calculation the weight of that portion of this mass which will be detached at the moment of the rupture of equilibrium. A distinction is thus necessarily established between the *pendant* (or entire) drop and the *fallen* drop.

Athanase Dupré (1866) occupied himself incidentally with the theory of drops. K. Lasswitz (1874) and E. Matthieu (1884) tried to treat the problem analytically, as did F. Neumann in one of his lectures on capillarity delivered about 1865 and published in 1894. But none of these had in view the specific verification of Tate's laws, and they confined themselves to the realm of pure theory.

It is Théod. Lohnstein in particular who, with the view of deducing from it the capillary constant, discovered some ten years ago a method of predicting the weight of the fallen drop, as a function of the diameter of the tube of flow and of the superficial tension of the liquid. The formula he derived is not the statement of a simple proportion like that which Tate believed himself to have established. He discovered that it is necessary to add to the equation a variable term, a function of relation between the radius of the tube and the capillary constant, or f $\left(\frac{r}{a}\right)$. We know that *a (the capillary constant)*, is in relation with the *superficial tension* γ, or α, in the following manner: $\pi = \frac{1}{2}a^2\sigma$. The value of f $\left(\frac{r}{a}\right)$ has been calculated by Lohnstein for a series of values of $\left(\frac{r}{a}\right)$ and arranged in a table. In applying the formula and the table to the numerical results of weights of drops and of tensions found by various other authorities for quite a large number of liquids Lohnstein demonstrated that the calculation corresponded satisfactorily to the observation.

Several others have attacked the mathematical side of the subject, among them Lord Rayleigh, who likewise arrived at a table analogous to that of Lohnstein, giving a corrective term to the formula of proportionality between weights and tensions. Kohlrausch proposed a fusion of the two tables and a condensation of the Lohnstein-Rayleigh formulas, and found that one thus obtained a very satisfactory concordance between the results of the calculated and of the observed tensions, especially with reference to our former measurements.

Apropos of a critical examination of the researches of J. L. R. Morgan we will return later to the theoretic results of Lohnstein, whose series of notes forms an ensemble which is important and in some sort opposed.

It is necessary also to call special attention to a publication by G. Guglielmo, who succeeded, by making the hydrostatic pressure intervene as a factor, in demonstrating that in the case of extremely small drops Tate's formula is applicable in its original form.

H. Ollivier, in a thesis called "Researches Upon Capillarity," devotes a chapter to dropping and verifies Tate's formula with regard to very small drops, accepting the theoretic results of Guglielmo. The very precise apparatus of Ollivier provided him with a convincing verification. Unfortunately the numerical results are reduced to a too restricted number in this work. Antonow, in measuring the superficial tension on the border of two layers has also made use of the little drops.

Let us pay special attention also to the note published by Leduc and Sacerdote in the *Comptes Rendus de l'Acad. des Sc.* of Paris for July 15, 1902; they found that Tate's law is theoretically inexact. Their opinion may be thus summarized: Tate's formula supposes that the drop is detached according to a circle, and that the weight p is proportional to the radius r of that circle. But if there be a detachment with relation to the surface of a circle, i. e., according to a plane section taken in the interior of the liquid mass, such detachment, in order to be effected, must overcome the cohesion which is exerted between the liquid strata above and below this section. The cohesion factor B must be introduced into the formula, which would then become:

$$p = Ar + Br^3.$$

Preceding experiments of the same authors having proved to them that the cohesion of the liquid is much stronger than had been hitherto suspected, it results that the term Br^3 is discovered to be much more important than A r (A being the superficial tension). The classic formula thus becomes theoretically inacceptable, if it supposes the rupture to occur according to a circle.

Leduc and Sacerdote add that in reality the detachment never takes place by *tearing*, but rather by *constriction*. A liquid mass forms and enlarges little by little below the plane of section of the tube with radius r. From the moment when the liquid begins to project beneath this plane there occurs an infinite succession of figures of equilibrium until the one is reached having a maximum volume of suspended mass, so that any supplementary afflux would provoke rupture of equilibrium and a fall. The constriction is produced by the exterior pressure, which prevails over the interior pressure, along a well defined parallel.

In our own publications an analogous point of view is expressed in slightly different terms.

In the second part of their note Leduc and Sacerdote have tried to ascertain whether Tate's formula gives satisfactory practical results. Their experiments were conducted with water and with mercury, and are summarized in a curve and some figures. It appears to be shown thereby that Tate's law is practically exact between certain definite limits of the diameter of the tube of flow: the ratios $\left(\frac{r}{d}\right)$ of the weights to the diameters remained almost constant for the values of d comprised between 0.5 centimeter and 1.5 centimeters. The too small number of these experiments, the very special nature of the liquids employed, and the considerable size of the radii r indicated, occasion doubts as to the value of this verification.

The chief publications upon this subject in a purely experimental direction proceed from the American school of physico-chemists, in particular from J. R. Morgan and his pupils. In the first of his notes he observes that it was all wrong to summarize Tate's law in the expression $P = 2\pi r\gamma$.

He says that "without doubt the second principle of Tate shows that the weight of the drop is proportional to the superficial tension, for the weight of a liquid ascending a tube by reason of capillary attraction is proportional to the superficial tension, and his first law shows that the weight of the drop is proportional to the diameter of the tube; but Tate did not imply that the weight of the drop would be equal to the product of the circumference of contact multiplied by the superficial tension. The true analytical expression of the first two laws, according to his statement of them, should be $P = K_1 \gamma D$, in which K_1 is a constant and D the diameter of the tube; or else if the drops are all formed by the same tube (if D = the constant) $P = K\gamma$, K being a new constant."

Morgan has on the whole attempted, and has apparently succeeded, in making the experimental results bend to the law of Tate, without a corrective, but this was accomplished at the price of multiple precautions and gradual restrictions. He has combined a quantity of observations, very considerable from the point of view of the knowledge of superficial tensions, by utilizing tubes of flow of special forms and dimensions. He graduates a tube with reference to a typical liquid whose superficial tension is very exactly known, having been determined by the method of capillary ascensions. He weighs the drop of the type liquid issuing from a selected tube. Thus is obtained the *constant* K of the tube, which permits the determination of the superficial tension of other liquids by means of the weight of their drops by the use of the simple formula of proportionality.

The numerical results thus obtained by Morgan and his numerous collaborators in the course of their 21 successive notes (which appeared in the *Journ. of the Amer. Chem. Soc.* between 1908 and 1916) exhibit in general a remarkable concordance with those obtained for superficial tensions by the method of capillary ascensions. The ingenuity of the apparatus employed and the care taken in the determination of the weight of the drops inspire confidence in this vast quantity of observations. However, after having seen Morgan maintain with conviction, at the beginning of his first note, the general validity of Tate's laws, one can not avoid, on reading the following ones and the discussion with Lohnstein, the impression of a gradual retreat and a confinement within the narrowest limits. Precautions are multiplied, and restrictions also, in proportion as certain liquids present themselves whose drops show themselves rebellious to the classic formula. It is at such a point that in one of his replies Lohnstein has emphasized under the very pen of his contradictor, no less than seven passages which in themselves are contrary to the general applica ion of the laws in question.

Before concluding it is necessary to consider in connection with the works which have just been analyzed some of the results noted in our second memoir.

This began by a study of dropping, starting with the liquid stream. Any one who desires to follow the problem in the direction of the recent researches of Vaillant and Abonnenc would do well to re-read what we have written in this portion. At present we will consider the question only from the point of view of static drops, recalling, in brief, what we discovered as to the form of drops.

The photographic views which M. M. Lumiere made for us supplied a desideratum by providing us with images of the *static drop* in the successive phases which precede its detachment. One can see in them also the forms presented by the liquid at the instant when the drop is detached, and finally its images during the first moments of its free fall.

The drops recorded on the film formed themselves at the extremity of a capillary tube having an exterior diameter of 3.17 millimeters. This tube was fed by a capillary tunnel having a very feeble discharge in order to assure a long duration of formation. The whole was placed in a glass box whose interior was saturated with the vapors of the liquid employed. Electric lighting afforded the advantage of giving against the surfaces of the liquid little reflected images of the lamp. These images indicate by white points on the photographs the existence of the various curves of the drop.

These "reflexes" have already been utilized by Lénard to characterize the phases of the vibrations of a drop during its fall.

We have presented the detailed analysis of the cinematographic bands relating to drops of slow formation. The most characteristic images on each band are reproduced in phototypes. The text describes all the phases of the formation and of the detachment.

In projecting certain views on our bands we have been able to fix thin enlarged positive images upon sensitivized paper. We have selected a series of eight of these proofs which exhibit the successive forms taken by the liquid in its issue from a 3.17 mm. cylindrical tube, and which occur many times on nearly all the bands. We have traced the contour of the drop on the proofs and have reproduced them in fig. 2.

In spite of their diagrammatic appearance the numbers 1 to 8 conform perfectly to reality. No. 6 relates to aniline, all the others to benzine. No. 8 was obtained by combining two views relating to the same phase. The views of 3, 4, 5, 7, and 8 succeed each other directly, while between 2 and 3 there are 27 views on one of the bands, and between 1 and 2 about 50. Hence there elapses a comparatively long time (the time required to unroll about 110 views) between the fall of the preceding drop and the moment when the liquid attains the form and volume which it has in No. 2. Starting with the instant when this form is acquired, a double curve begins to exhibit itself clearly by the separation into two reflexes of the single elongated reflex. The superior reflex denotes the existence of a volume of revolution, very nearly conical, which is applied against the right section of the tube. The inferior reflex characterizes the portion of the drop blown into a bag which will detach itself later. After the separation of the reflexes the liquid is rapidly constricted between the portion in the trunk of the cone and the portion in the bag; the two portions join together gracefully enough by the surfaces of revolution (No. 5). At the same time the ensemble of the drop is elongated downward, presenting the "pencil point" figure referred to by Lénard, immediately after which the rupture of the ligament takes place. This rupture must be effected at two points, for the ligament resolves itself into a droplet; the principal mass falls vibrating elliptically as if the liquid were broken as if it were a spring, and a final portion contracts against the section of the tube where it takes the form of a convex munscus.[2]

[2]It may be remarked that the withdrawal of the liquid before its detachment, and the series of forms shown from 4 to 7 in., fig. 2, may be followed by the eye when a very viscous liquid is dropped, such as honey recently extracted from the comb. With a capillary having an exterior diameter of about 3 millimeters, and an interior diameter of one millimeter, the interval of fall may be from 7 to 10 minutes. The preliminary forms do not seem to differ much in general between liquids of average viscosity and those of very great viscosity; but the length, and consequently the *duration of existence*, of the constricted part are notably greater in the more viscous, which must exert an influence upon the distribution of the liquid between the fallen drop and the meniscus. Perhaps it is just here that we may seek, comformably to an indication by Hannay, for one of the causes of the lack of success of the classic formula.

Having recalled this iconographic fixation of certain terms of the problem, we can proceed to draw conclusions.

The works which have just been reviewed may be classed in two categories:

a) Those in which an attempt is made to amend the so-called Tate's law, so as to render it applicable to liquids in general and to the usual diameters of the dropping tubes. Included in this category are the following authors: Traube, Duclaux, Rayleigh, Guye and Perrot, Lohnstein, Kohlrausch, Harkins. Lohnstein's series of memoirs appear to be among the most thorough of theoretic results in this direction.

b) Those in which the conditions of the formation of the drops are circumscribed, so as to render Tate's formula applicable without change in these special conditions. In this category are included the researches of Antonow, Ollivier, Morgan; Guglielmo may be included in both categories. The memoirs of Morgan and his collaborators are those which seem to be most satisfactory in this direction.

The works of Morgan have by no means solved the problem of the weight of the drop as a function of the diameter of flow and of the superficial tension in all possible experimental conditions. It is only by the choice of a special method of operation that he has succeeded in making use of the formula of proportionality without employing corrective terms. The consequent result is that, even for drops formed at the extremity of tubes of the sort commonly known as "droppers," Tate's formula is applicable only to those of specific form and dimension. In fact the detailed examination of the numerical results obtained by Morgan, and that of the profiles of drops of liquids observed by other authors, tend to give the idea that things occur differently with different tubes for the same liquid, and also with different liquids for the same tube. However, when liquids having analogous general properties are concerned (solutions in the same solvent, homologous series, etc.), Tate's formula can be used, apparently, without correction.

Lohnstein has sufficiently sifted Morgan's researches to allow us to refrain from insisting further upon their theoretical insufficiency. For his own part he has established by analysis a relation based exclusively upon capillarity, and which causes the intervention in the equation of proportionality of a function $f\left(\frac{r}{a}\right)$.

The verifications of the new formula made by himself and others, by applying to it the weights of drops found by experiment, have in general been sufficiently satisfactory. But Harkins and Humphrey, who accept Lohnstein's solution as very good, say, however, that the calculation of $f\left(\frac{r}{a}\right)$ was not carried out precisely enough by Lohnstein, and that his table can not furnish results of an exactitude greater than 4%. Furthermore, Lohnstein's formula can not be made use of except by the aid of this table of the function $f\left(\frac{r}{a}\right)$, corresponding to a series of values of the ratio $\frac{r}{a}$. It presupposes, therefore, the knowledge of the factor *a*, which itself depends upon that of the superficial tension. If therefore Lohnstein's formula enables us to find the weights of the drops by means of the radius and the tension it does not give directly the solution of the inverse question, more interesting by far, of how to find the tension by means of the weight of the drop. To arrive at this latter result it is necessary to proceed by successive approximations by extracting a provisory primary value from *a* of the old classic formula. This *a* will enable us to calculate a and $\frac{r}{a}$ for each experiment, and then to choose the corresponding $f\left(\frac{r}{a}\right)$ in the table. We should then be able to extract from the new formula a value of *a* already better than the provisory one, and so on. We have found that this process was indicated by Kohlrausch.

Harkins, in a study of Lohnstein's formula made with Humphrey in 1916, conceived the idea of two apparatus operating concurrently, one to measure the weight of the drops, the other to measure ascensions. He thus obtained P and *a*, and could then utilize Lohnstein's formula and his table for the measuring of *a*. This double operation justified itself in a verification research, but it would deprive of all practical character the measurement of superficial tensions by the weight of the drops, since it was in order to avoid measuring capillary ascensions that there has been made such an effort to utilize the simple weighing of the drops.

What we reproach Lohnstein with, is having based his conclusions exclusively upon the capillary theory. He has taken into account neither the influence of the hydrostatic pressure (remarked by Guglielmo and accepted by Ollivier), nor cohesion (noted by Leduc), nor rigidity, etc. It is quite possible that the rôle of these various factors may be very slight, or even that it may not intervene, or that their effects annul each other; but even so it is necessary to be sure and not to ignore them in presenting the data of the problem.

In this connection we have read with satisfaction on p. 225 of Memoir I of Harkins and Humphery, that E. D. Wilson has undertaken to make calculations more complete than those of Lohnstein by introducing other factors into the equations, viscosity in particular. He hopes thus to explain how it happens that the experimental results of Morgan, so worthy of confidence, do not agree more satisfactorily with those calculated by means of Lohnstein's formula.

But it is necessary to give special consideration to the process of the detachment of the drop. After having laid aside for more than a dozen years the question of drops in order to devote ourselves to other investigations, we have recently been studying and reviewing all the researches in this line by others since our own were made. But on re-reading the conclusions with which our second principal memoir ended we find that we have no occasion to modify them. We still believe (with Leduc and Sacerdote) that drops issuing from tubes of the ordinary size of "droppers" are not detached from a tearing surface, but by "strangulation," i. e., constriction in such manner that there is a division between the meniscus and the falling drop. This parting necessarily takes place dynamically during a very short interval of time. Hence so long as the problem is analyzed from the static point of view nothing absolutely definite can be established.

The adoption of the qualification *static* for drops formed very slowly, in opposition to that of *dynamic* for those formed rapidly, does not imply that in the first all dynamic effect is spent at the moment of their detachment. In fact we do not see how a detachment in a liquid mass can be conceived of except as the product of certain forces producing some movement of the mass.

No formula in which there intervenes as parameter the radius of the surface under which the entire drop was primarily hanging can be, *a priori*, strictly applied to the estimation of the fallen drop. The detachment taking place by strangulation, the radius of the constricted portion passes by degrees through a series of values until it becomes equal to zero. However brief the period of strangulation may be, its duration is not *nil*, and it allows the possibility of an afflux from the upper part to the lower part by way of the strangulation. Moreover, if the strangulation begins to be exhibited at a certain level, and according to a certain circle, far from remaining at the same level this circle will descend while contracting as if it were sliding down an inverted cone. Obviously the process of detachment is bound to be very complicated.

It is the cinematographic analysis of the detachment of drops of benzine and of aniline which has confirmed us in the preceding views. Perhaps experiments operating upon a larger number of tubes and of liquids by an analogous process may some day lead to a closer grasp of the problem. It may be predicted that it will always remain, under its apparent simplicity, very difficult to analyze mathematically, and to express by a formula permitting the calculation of tensions by means of the weight of drops and of other experimental data.

Meanwhile we may form the following conclusions:

1. The classic formula of the proportionality of the weight of the drops to the superficial tensions, $P = 2\pi r\gamma$, must be definitely abandoned; it is merely a fallacious approximation.

2. The term *law* must not be accepted to designate the statement of Tate.

3. The theory of Lohnstein, in spite of its too exclusively capillary and static basis, can be accepted provisionally with advantage to replace the old classic formula of proportionality.

4. For purely experimental investigations, particularly from the physico-chemical point of view, Morgan's process may be employed, on condition of operating within the limits, and with the restrictions which the author has been gradually led to impose in the course of his investigations.

5. A relation giving the weight of the fallen drop in connection with all the properties and the movements of the liquid which may concur in determining it still remains to be found.

Psychotherapy*

By Siegfried Block, A. M., M. D.

As a definition, we may all regard psychotherapy as that form of medical treatment in which the therapeutic agent is the mind. This particular kind of therapy is as old as history itself. In order that it may be properly understood, it is perhaps wise to clear our thoughts definitely, and differentiate two forms of illness that are frequently confused—an imaginary disease, one that does not exist, one that is not present, an hallucination of sickness, etc.—in contradistinction to a real, genuine disorder whose cause, pathology or diagnosis is not discernible by the examining physician. Too often a patient of the latter group is regarded as a sufferer of the first and an improper diagnosis is directly responsible for wrong treatment—in some cases for a life of prolonged misery. Some of the more modern opinions regarding certain tics, paralyses, hysterias, melancholias, convulsive seizures, obsessions, acnes and a score of other states of mind and body are ample proof of these statements.

It is needless to state that it is impossible in a short paper to cover a subject on which so many volumes have been written, but a summary, even brief and incomplete, may be interesting. Faith cures, which include the various religious sects and fads, the fetishes or good luck objects either carried around or applied in a definite way to some part of the body, the laying on of hands, many of the electrical, mechanical, hydrotherapeutic and dietetic treatments, all have their place, especially in that group of ailments which we call imaginary. These, according to the type of patient, may be of most value in public or in private, either at home, in a hospital, in a sanitarium, in a church, or in the administrator's office.

These treatments are not dishonest in premise or purpose; they are not "fakes" so-called, as charlatany or quackery of licensed medical practitioners. The latter group set out to deceive their patients. They are after the fee, no matter what the progress of the patient's malady. They steal, and too frequently are not punished. As an example may be mentioned the poor unfortunate drug addicts. They go to one of these imposters and receive a solution of the drug which they are taking, disguised in taste or color, or both, and gradually become worse than before. They pay the quack for their hastened downfall. They get their dope at a fancy price from the easiest source.

The bona fide faith cures seek to overpower the patient's uncontrollable mentality, i.e., the subconscious mind, which in some cases troubles the patient so that his higher mental powers fail to act as they did before his attack. Let us recall briefly what is meant by the subconscious mind. In ordinary divisions of mental functions we recognize our powers as conscious, unconscious and subconscious. Conscious mentality, or conscious mind, is controllable thought, reason and judgment. When this is entirely absent we are said to be unconscious. It is not difficult to perceive a state of mind which is intermediate between these two places. The brain has so many centers, and so many fibers and associations tracts which connect these and intermingle, that in certain conditions the higher coordinating or collection centers for the lower association centers become confused or subservient to the association or subconscious centers. This actually occurs when a person dreams, is hypnotized, is bewildered, becomes delirious, shocked, hysterical, etc.

Faith depends not on reason at all, but only on the recognition of a belief so-called. Here we have subserviency of the conscious mind to the subconscious mind. It is usually impossible to reason with a man why he should change his religion. Tell him that his particular belief is founded on a false premise, and his judgment and higher reason may lead him to admit it. But deep in his mind against all reason he still will have faith in his belief. This man who could not be reasoned with, or argued out of his particular idea, at some religious meeting, where his intense awe, i.e., subconscious mind, not his reason is appealed to, may at once change to become a faithful servant of an entirely different creed.

Most of Billy Sunday's converts know he uses language and similies far from what one might expect to hear at a church meeting, yet they accept his views when their reason is not consulted. His character and conduct have been depicted so many times in the newspapers that one is amazed at his success in fighting the devil. He does not permit debate, he does not want his audience to think carefully, he does not desire sound philosophy. No! he gets his audi-

*From *American Medicine*.

ence bewildered and confused. Each one says to himself, "sure you are right." "We're with you," and before opportunity to think it over is granted the individual is "converted." If he were to stay long in one place and the people given a chance to study and think him over carefully, his powers would sooner or later vanish. It is this kind of faith treatment that every physician uses with his patient, whether he does it consciously or not. The expression, his talk, his demeanor, etc., is what the patient notices much more than most of us realize. These patients know, when reasoned with, that these trifles about their doctor have nothing to do with a case of infection, for instance, yet the activities of the subconscious mind of the sick person which the laity call hope or faith are affected, and the patient feels accordingly. Dr. H——— of Cleveland sent his wife to me for a facial paralysis only because he had this kind of faith; he could have given his wife the same treatment, as he is a skilled neurologist who knew the diagnosis quite well.

We as physicians must not permit a patient's faith or subconscious self to mask the symptoms of the real malady so that the diagnosis may become obscured to us. There is no doubt that some people, when they become more ill and less alert in their higher mental activities, often permit the subconscious mind to rule their actions and feelings, and give the impression of improvement to their family. This probably accounts for the statement that many people feel better just before death. Their highest functions are entirely dominated by the subconscious mind. All psychotherapeutics depend for their virtues on the basis of an attack on the patient's subconscious self, and only so may their workings be explained. The laity is too easily led to believe in superior powers, spirits and other ridiculous things. Supernatural, or in plain language unnatural, powers do not exist in this age except for ignoramuses.

Psychoanalysis is the study of the subconscious mind of the patient. The theory of treatment based thereon is that many psychic disorders are due to mental conflicts of the subconscious and conscious minds. After frequent conversations the psychoanalyst is able to judge his patient's innermost feelings and thoughts. After each visit the important points are written down, and, in the course of study pursued, a conclusion by an experienced observer has much value. As an outsider not interested in the same way in the patient's matter of mind, it is often possible to determine the cause of the patient's suffering. Subconsciously the patient may dislike very much, even be disgusted with, some person or some activity, etc., while perhaps consciously the same individual may have to carry out a pretense of liking for these things because a family strife is to be avoided, or the earning of one's daily bread depends upon it, or life itself. These may not manifest their influence at once, but after a long continued series of psychic conflicts the person is psychically overcome, and the condition may even end in insanity. The repression of those things which law and society hold sacred, or secret, such as sexual perversions, hate of one's wife, brother or sister, love of another man's wife, etc., are all fundamental factors in many cases in which psychoanalysis can often be used to great advantage.

Suggestive therapeutics are another agent of psychotherapy. In this form of treatment the administrator suggests to the patient how he is to think, feel or act; often this suggestion is given to the patient in the form of regular conversation. He is reasoned with by the psychotherapeutist, and may accept the thought submitted to him. A more profound plan of suggestion is one in which the patient is unaware of the suggestions as, for example, those derived from seeing a play with a given lesson, or from ideas gathered from reading a book, etc. These are usually much more acceptable and persistent to the subconscious mind than those made by a direct appeal, which always encounter the conscious mind, so much that the subconscious mind is not able to overcome the controlled judgment of the higher centers.

Suggestive therapeutics may be administered to some persons by hypnotism. This word means the sleeping state. When we dream we are subconsciously active; only the conscious mind is at rest. In hypnosis this dream state is induced. The brevity of this paper does not permit of detailed discussions of methods to induce hypnosis; suffice it to say that drugs which are not narcotic, but only hypnotic, are often of value. Just as the drugs are causing the patient to slumber, and before deep sleep has taken place, suggestions, positive and definite in purpose, may be successfully made and have much value in some cases. Before the patient wakes up—as the sleep is becoming less deep—these same suggestions will often bring good results in a few cases. If we wait until the patient is unconscious from the drugs he cannot hear the suggestions, and it is useless to give them. The purpose of this method is to get closer affiliation with the subconscious mind unmolested by the conscious mind. In other words, we go directly to the sick member, unhindered by any extraneous influence. It is possible to weary the conscious mind by work overstrain, so-called concentration; thus it becomes tired, rests and the subconscious mind then predominating can be influenced by suggestion. This method of suggestion is also termed hypnotism. Certain types of hysterics, somnambulists, obsessionists, etc., are constantly in this state, and in consequence are most easily treated by hypnotism. Their subconscious mind is to the fore, and does not have to be sought out of a general mental cosmos as in most normal individuals. That is why these persons are said to be more susceptible to suggestion. The most unstable periods of life are the best time for suggestive treatment, as during puberty and menopause. It is true that most criminal, prostitute, drunkard or other freakish careers start at these ages from suggestions which may come from environal conditions. These are also the periods of life when religious converts are obtained most easily.

Rest cures are other types of treatment associated with psychotherapy. These may be carried on in or out of hospitals or sanitariums. The Weir-Mitchell treatment employs complete rest with overfeeding. The object is to give comfort to a tired mind, and isolation is employed to keep any environal influences from the highly nervous.

The author has used in the last few years an original and a much more powerful type of rest treatmen which must be carried out in a hospital. It is particularly useful for those persons whose minds are what the Germans call "uberspannt," that is, in an "overbent," or overstrained condition. The idea is to overcorrect the mental infirmity. As in a physical condition we do more than just straighten a crooked leg, so this plan also seeks to do more than really rest a weary mind. As this method is well known it is hardly necessary to spend time to discuss it in detail at this moment.

In conclusion—psychotherapy has a definite place in medicine, but to have it carried out by the laity or the unskilled is criminal. Many persons have become mentally deranged and psychically worse from improper treatment of their subconscious minds. Psychoanalysis has also done much harm; it has been used to interpret dreams, and some of the most ghastly, indecent and immoral translations have resulted from uneducated and unpracticed psychoanalysts.

Hypnotism—or induction of a dream state—has made hysterics more hysterical, and has increased misery very markedly when improperly used. It is not possible to go into detail at this time. Suffice it to say that harmful as it would be to treat consumption, cancer or poliomyelitis by faith, it would be equally disastrous to apply improper psychotherapeutic measures to serious mental disorders, for thereby weak and perverted minds may be permanently injured.

A well-trained neurologist, who is able to make a proper diagnosis, and who is at the same time a man with a good psychologic understanding, should be the only one permitted by law to delve into these delicate matters. Only then may we expect some good to come from this kind of therapy, and then only will public health be protected from charlatanry, whether in the guise of religious teaching, pseudophilosophy or quack medicine.

Alcohol as a Fuel for Internal Combustion Motors

When it is desired to run on alcohol an engine which is designed to work with gasoline, certain alterations must be made if its power, output and efficiency are to be maintained. These are as follows:

Increased Compression.—One of the most important alterations necessary will be to increase the compression of the engine. This may conveniently be effected by putting liners between the big end of the connecting-rod and the crank-pin brass. This alteration should be made with care, as in some types of engines there may be trouble due to the increased stresses put on the various parts. If, after the compression has been increased the engine can still be pulled over by hand, it will start more easily than before. A half compression device for starting will be necessary in engines in which the compression has been increased to any great extent.

Pre-heating of Air and Alcohol Vapor.—Another important alteration necessary is to provide some means for heating the incoming air. Alcohol will not vaporize at ordinary temperatures, and if the engine is to work satisfactorily heat must be added. It will be difficult to make the incoming air too hot, and a sleeve, 2 or 3 feet long, surrounding the exhaust pipe and connected to the carburettor in such a way that the air must pass through its full length, should be added to secure good results. If practicable, the mixture of air and alcohol vapor, after the addition of the extra air (see v below) should also be heated by the exhaust gases.

Reduced Water-cooling Circulation.—Another alteration necessary is to decrease the amount of cooling water, which should be reduced to a minimum in order to keep the cylinder as hot as possible. It should always be remembered that, with an alcohol engine, the circulating water does not heat to the same degree as it does with gasoline or kerosene, and that for efficient working the cylinder temperatures must be high. It is not recommended that the fuel be heated, as with all ordinary designs of carburettors sufficient heat will be conducted through the metal body of the carburettor to heat the fuel, and over-heating of the fuel leads to erratic running of the engine. A rough test of the proper temperature of the carburettor is to ascertain if the hand can just be kept against it.

Increased Jet Orifice of Carburettor.—The jet orifice of the carburettor should be increased. Generally it will be advisable to have a new jet made in which the area of the orifice is enlarged so that the fuel supply is increased by about 50 per cent. The exact degree of enlargement should, if practicable, be determined by actual experience while running the engine. In most carburettors this can easily be done as the jet is ordinarily removable.

Auxiliary Air Supply.—It is also necessary to make provision for an adjustable extra air supply between the carburettor and the engine. In working the engine a full supply of extra air should always be present, as it reduces the possibility of corrosion and the pitting of valve seats and faces which may occur with the presence of acids in the exhaust.

Carburettor Floats.—In the case of carburettors having cork floats, these floats are nearly always coated with shellac, which is soluble in alcohol. It is recommended that after cleaning the varnish off the float with alcohol, the float should be well dried, coated with boiled linseed oil, and baked in an ordinary oven till a hard skin forms all over the float. The process of coating may be repeated if a thicker surface is desired.

Enlargement of Fuel Pipes.—In some instances where small fuel supply pipes or small fuel filters are used it may be necessary to enlarge them in order that the engine may have a sufficient supply of alcohol.

Exhaust Drain.—It will be necessary to see that the exhaust pipe drains properly so that in the case of moisture appearing in the exhaust gases it can drain away freely, and corrosion of the exhaust pipe be avoided. It is only when the exhaust gases have cooled down, as they do in a silencer, that trouble need be anticipated in this respect.—Bulletin No. 6 of the Advisory Council of Science and Industry, Australia.

Effect of Some Aldaline Salts Upon the Fire-Holding Capacity of Tobacco

Tobacco leaves were sprayed with 28.9 per cent solutions of the respective salts, and, after being left under a bell jar, pieces were cut from the tip, middle, and base of each leaf, and the duration of their combustion determined. The results showed that the carbonates of caesium, rubidium, and potassium have a pronounced effect on the fire-holding capacity of tobacco, whereas the carbonates of lithium and sodium have not this effect. Of the oxalates tried only potassium oxalate had any effect. Potassium citrate also promotes the burning properties, but the citrates of sodium and lithium have practically no action. Organic salts of potassium, tripotassium phosphate, dipotassium phosphate, and potassium sulphate promote the combustion, but the chloride, acid sulphate, and monopotassium phosphate have a bad effect. The favorable action of potassium salts is not due to their reduction, nor is the injurious effect of chlorides due to their melting, but it seems probable that the favorable salts may have a specific catalytic action upon the combustion, whilst chlorides have a negative catalytic action. Possibly the effect of salts in raising the temperature may also play a part in the process.—Note from *Jour. Soc. Chem. Ind.* on an article by R. Kraybill in *Bot. Gazette.*

World Economics Now Being Taken Up by Germany

A SUITABLE and at the same time genuinely German reply to the plans of the Paris Economic Conference, proposing to cut off Germany from the world's market, is the laying of the foundation stone of the "Institut für Seeverkehr und Weltwirtschaft" (Institute for Sea Trade and World Economics). It proclaims that "we Germans are not willing to renounce our position in the world's market, and mean to proceed systematically to recover old possessions and acquire new ones."

During the few years of its existence, the Institute for Trade and World Economics has already shown how merchants and scientists can work hand in hand in order to raise Germany's economic position. In the midst of war, this centre of investigation has found its premises, which were opened a few months before the outbreak of the war, too small—the number of its full-time staff, male and female, having increased to 100, besides numerous outside collaborators; the number of newspapers and periodical publications scanned for news items worth noting has increased to 1400 (including 639 home and 761 foreign). The number of letters and packages sent out by mail alone—amounting in 1914 already to 9162, and in 1917 to 610,300—proves what brisk relations the Institute maintains with the most varied parties. No wonder that its premises threatened to become inadequate. Therefore, a handsome, but by no means luxurious abode—so to speak, a "Garden Institute"—is to be erected for it, in splendid surroundings with an outlook upon the sea.

A long-stretched structural arrangement, partly set back from the roadway, was the only imaginable solution of the problem, for this locality of uncommon scenic charm, and this requirement has been met by designing the structure so as to consist of two transversal buildings—or side wings—opposite to each other and connected in the middle by a longitudinal wing—of aisle—to which, at the back, opposite to the main entrance, the large working hall is annexed. The length of the whole building is 100 m., the depth of the end wings 60 m., the area built over will be about 4000 square metres, the cubic measurement of the structure about 80,000 cubic metres.

But will the aim[illegible] correspond to the great [illegible]? The nature and importance of "world-economic" relations has scarcely ever been so clearly demonstrated to anyone as to the Germans in the present war. Before the war, both scientists and laymen were much inclined to speak of "world economics" as "export relations," and to make calculations as to what quota of the production of the economic systems of the various nations went abroad, and how great, accordingly, was the "world economic interest" of this or that country. As regards Germany, it has even been calculated that the export quota was retrogressing, and that consequently a decreasing importance was to be assigned the "foreign trade relations." The war has cut away the ground from under the feet of such theories. To-day everyone in Germany is feeling the breath of "world economics," though unfortunately in a negative sense. The very interdependency * of German "world economics" in nearly all branches, as revealed by the war, has been a stupefying surprise to many. No theoretician could have revealed the thousandfold ramifications of the relations of German economic life with foreign countries as the English blockade has done. The effects of the commercial war have, moreover, shown how remunerative an object is formed by German property abroad; compulsory administration and liquidations of firms, withdrawal of patent and trademark protection, black lists and the like, have found a field of application of a magnitude, of which, before the war, even the initiated has scarcely a right conception. In short, the world economic relations are to-day occupying a central position in the world of our thoughts. This will be no less the case when the war on the battlefields is ended.

What, now, is the "Institute for Sea Trade and World Economics" going to do? On the one hand, it will present, on a systematic plan, the totality of the international processes of inter-ramifications and their reactions on the various national economic systems as well as, within these, on the various categories of individual economic systems, in order to proceed in this way to the development of a special branch of economic science, viz., the science of "world economics."

Secondly, the President of the "Gesellschaft zur Förderung des Instituts für Seeverkehr and Weltwirtschaft" (Society for the Promotion of the Institute for Sea Trade and World Economics), H. Diederichsen, has stated:—"The Institute is to assist, as an educational institution, to render the rising generations efficient for their tasks. The training, in national economic and world-economic respects, of the future managers of industrial and commercial concerns, of the economic officials, of the representatives of our private and legal interests, of those engaged in the diplomatic and consular service, and last, not least, of the large number of officials who, in the Empire, and in the Federal States thereof, come into contact with the economic and social life, and exert an influence on its development, is a task of pre-eminent importance. As a "centre of research," the Institute is to carry on, in closest touch with practice, the scientific investigation of the world economic relations in their entire compass. Outside of all conflicts of interests it will thus, by extensive compilation and dissemination of knowledge of facts and interrelations of facts of economic and social life, contribute towards creating the pre-requisite bases for systematic, practical action in all departments of world-economic activity.

But the men conducting the economic enterprises need not, in this respect, be merely recipients; the problems propounded by the Institute can only be solved satisfactorily if practice throws open to the theoretician its workshops and offices, if it renders accessible, to the scientist, the roads into the wide spheres of its activity. The science of economics is dependent on practice, because the latter can supply it with raw material. It is the very task of science to elaborate this raw material by precise work into a finished product. Practice itself, as a matter of principle, should hold aloof from this process of elaboration, just as it does not require, nor claim the assistance of science when it is a question of practically applying the absolute results of research." Similarly, Max Warburg, Member of the Board of Administration, emphasises:—"Industry and commerce, men of science and men at the head of economic management, can very well work hand in hand. . . . But industry and commerce should never attempt to influence science directly, as science does not allow itself to be influenced in its conclusions by the currents of the opinions of the day."

Hitherto the Kiel Institute has been conducted by its head and creator, Professor B. Harms, in this spirit. The composition of the Board of Administration is a guarantee that this spirit will continue to rule, as is also the circumstance that this Institute is attached to Christian Albrecht University.—From *The Engineer*.

* "Anhängigkeit" is a rather unusual noun; the adjective "anhängig" is sometimes used, in the sense of "adherent, annexed, connected, interrelated," hence it might mean interrelation; but it may possibly be a misprint for "abhängigkeit"—"dependency."

Parasites of Crops and Cattle

VERY striking data as to the extent of the loss of crops occasioned by diseases of parasitic origin are contained in the paper on economic mycology read by Prof. M. C. Potter at the Newcastle meeting of the British Association (1916), and since published in the Journal of the Royal Horticultural Society (vol. xlii, parts ii and iii). In the year 1891 the loss to the German Empire upon the total cereal crops was estimated at more than twenty millions sterling, an amount nearly equal to one-third of the total value of the crop. In the same season (1890-91) the loss due to rust of wheat in Australia was estimated at two and a half millions. The case of potatoes is even more notorious. In Germany the loss due to disease of the potato crop amounted in one year to 30 millions, and in our own country it is computed that, on the average, the crop is reduced by disease by at least one-third. It is estimated that in Northumberland and Durham about half the crop of swedes and turnips is destroyed in average years by parasite attacks. Losses of timber also are very serious, and probably amount to one-third of the whole. Other crops, such as tea rubber, hops, and every kind of fruit, greenhouse, and garden crops, all pay a heavy toll to fungus diseases. A plea is entered for greater encouragement by botanists to the prosecution of research in phyto-pathology and for the wider treatment of the fungi in ordinary botanical courses, especially from the point of view of their work in Nature. The scope of the problems awaiting solution in this field is abundantly illustrated, and appreciation is expressed of the increased attention and support given to it in recent years by Government departments and other institutions, although further provision is still urgently necessary.

A report on investigations into the cause of worm nodules (*Onchocerca gibsoni*) in cattle by Messrs. C. G. Dickinson and G. F. Hill has been issued as a Bulletin (C. 9341) by the Government of the Commonwealth of Australia. Two series of experiments were carried out in the Northern Territory with calves from nodule-free districts of Victoria. Calves grazing on high, dry ground along with infected cattle became infected within eight months of arrival, whereas similar nodule-free calves did not become infected during the same period when enclosed in an open pen with concrete floor within 30 yards of a paddock within which affected cattle were depastured, although exposed to the attacks of winged and apterous Arthropoda. The results, while not revealing an intermediary host of the parasite causing Onchocerciasis in cattle, have definitely excluded certain species that were regarded as possible vectors, namely *Lyperosia exigua*, *Stomoxys calcitrans*, *Tabanus masteri*, *T. nigriturris*, *Boophilus australis*, and any purely aquatic forms other than those possibly found in the bore-water. Various common species of mosquito, it is tyought, may also be excluded. Wild swamp buffaloes were not affected, whereas wild Zebu cattle and domestic cattle grazing on the same country are invariably affected.—*Nature*.

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